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# Promotion Tempo and Enlisted Retention

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# PREFACE

Previous retention research has concentrated on military/civilian pay levels and has largely ignored changes in military promotion timing. Over the past several years, promotion tempo has slowed considerably in the enlisted force; the implications of the slowdown, however, have received little attention. This study examines factors that affect promotion timing during the first-enlistment term and examines how changes in promotion tempo affect the first-term retention decision. By neglecting promotion effects, manpower planners have been unable to accurately predict retention levels and anticipate how changes in key policy parameters such as military pay will affect retention.

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# SUMMARY


## BACKGROUND

This study examines the effect of promotion opportunities on the retention decisions of soldiers at the end of their first enlistment term. Historically, most enlisted personnel have reached paygrade E4 at the end of their first term and are competing for promotion to E5. In recent years, promotion rates have fallen substantially from their historical levels and average E5 promotion tempo was about 20 percent slower in 1991 than it was in the early 1980s. This slowdown has meant that the average soldier was waiting another 9 and 16 months for promotion in the Army and Air Force, respectively. These long delays mean that simple measures of relative military/civilian pay are not a reliable gauge of military competitiveness vis-à-vis the civilian sector. Retention rates reflect effective military pay, including promotion opportunities, and not just the nominal pay level at the end of the first term.

Promotion has received little attention in the retention literature. Most studies have focused on pay levels and bonuses, and the literature has largely ignored the potential relationship between promotion tempo and retention. Some models have used average promotion times to impute future military earnings, but these studies have not had access to detailed information on individual promotion opportunities. This data limitation is important because the promotion system is much more transparent to soldiers at the end of their first term than to the researchers who are struggling to examine their retention behavior. Soldiers know their position in the promotion queue—the cut score (the number at or above which a soldier is promoted) for promotion to the next grade—and are advised on steps that would enhance their promotion chances. Other things equal, soldiers with good promotion prospects have higher effective military pay than the average soldiers and should be more likely to reenlist at the end of the first term.

## APPROACH

A joint, integrated model of promotion and first-term retention behavior is developed and estimated. The model is estimated for the Army and the Air Force, and the results are compared with those from previous approaches that use little (if any) promotion information. The

proposed model nests earlier approaches as a special case, so comparisons are made for comparable variable specifications and time periods.

The study concentrates on first-term reenlistment and promotion to paygrade E5. The first-term reenlistment point has been the focus of most retention research, because the first-term decision is a critical point for moving enlisted personnel into military careers. Historically, about 40 percent of those soldiers completing their initial term have chosen to stay in the military. At the second-term reenlistment point, 70 to 80 percent of soldiers continue on in the military. The most relevant benchmark for soldiers at the end of the first term is their E5 promotion status. Some will have recently achieved E5 status, some are promotion eligible for E5 and have positions in the promotion queue, and some are E4s who have not yet reached eligibility for E5. Promotion status varies considerably with individual characteristics such as aptitude, proficiency, and interest in the military, but the promotion queue will also reflect demand conditions like overmanned occupations and small enlistment cohorts.

The Army and the Air Force have very different promotion philosophies. The Army essentially promotes to fill vacancies, so that promotion rates vary considerably across occupations. In hard-to-fill specialties with low retention rates, the promotion tempo is high as an incentive to encourage retention. The Air Force system is predicated on equal promotion opportunity, and promotion rates vary little by occupation. The Air Force uses promotion to reward its best airmen irrespective of occupation and then uses other incentives to retrain those airmen in other specialties if overages occur.

## RESULTS

The results demonstrate that retention models are sensitive to the specification of individual promotion opportunities at the end of the first term. Expected time to E5 promotion has a significant effect on first-term retention in both the pay ratio and the annualized cost of leaving (ACOL) formulations of the retention model. Other things equal, a 10 percent promotion slowdown is associated with 14 and 8 percent reductions in Army and Air Force retention rates, respectively. The results show that traditional retention approaches have not adequately controlled for promotion tempo. The strong effects of promotion tempo on retention persist even in the ACOL specification that adjusts for average promotion opportunities. We also found a comparable effect of promotion timing after the promotion effect was monetized into the ACOL computation—an indication that promo-

tions are associated with substantial nonpecuniary benefits over and above the monetary value of the promotion itself. By the end of their first term, individuals are well informed about their promotion prospects and their ability to improve them, so their retention behavior will reflect their individual promotion opportunities over and above those of the average soldier, as specified in previous retention research.

Our approach also shows that several key parameters of traditional models have been misleading because those models have not adjusted for promotion timing. The most important policy parameters associated with those models is the military pay elasticity, and our results show that the elasticity estimates are sensitive to individual promotion status at the end of the first term. The Army pay elasticity estimates fell about 60 percent after adjusting for promotion timing. The pay elasticity was estimated as 1.7 and 1.8 with the pay ratio and ACOL retention approaches, respectively, but the elasticity in the joint promotion and retention models was about 1.1 with both approaches. In the Air Force, the pay elasticity was lower than in the Army, and the effect differed somewhat with model specification. The Air Force pay elasticity was estimated as 1.6 and 1.0 with standard pay ratio and ACOL model specifications, respectively, but the estimates fell to 1.1 and 0.4 when promotion timing was incorporated into the corresponding pay ratio and ACOL models.

The joint promotion and retention framework is particularly important for sorting out the supply effects of important measures of soldier quality. The omission of promotion tempo in traditional model specifications means that the supply estimates are biased and represent the combined effects of promotion tempo and retention. The traditional models show that position in the Armed Forces Qualification Test (AFQT) percentile has little effect on retention, but the results from the joint model show that the AFQT effect on retention is about four times greater after controlling for promotion time—a 15 percentage point increase in AFQT implies about a 4 percentage point retention decline. Similarly, traditional estimates have substantially over-stated the "taste" of well-educated soldiers for the military. Tradi-tional estimates show that soldiers with some post-secondary schooling have retentions rates comparable with those of soldiers with only a high school diploma, but the "true" supply estimates after adjusting for promotion tempo show that these better educated soldiers have retention rates 6 and 8 percentage points lower than those of diploma graduates. Aptitude and education level have important effects on retention, but these effects are confounded by traditional

retention approaches that do not adjust for individual promotion opportunities.

The detailed analysis of occupational areas has shown that key policy parameters vary significantly across occupational groups. Promotion timing remains a key variable in each Army and Air Force occupational area, but the magnitude of the pay and promotion effects differ substantially across these areas. These occupational differences suggest that the services should be cautious about molding their policies to models based on data aggregated across broad occupational groups. Some occupations are inherently easier to man than others and are much more responsive to pay and promotion incentives. Similarly, the results show that some occupations are much more sensitive to civilian employment opportunities than others, so manning difficulties will vary disproportionately across occupations over the business cycle.

Our analysis has relied on critical information on individual promotion points and history. This information is not maintained in the standard personnel databases, but the information is important for predicting individual promotion timing. The criteria for E5 promotion are objectively defined and clearly visible to soldiers at the end of the first term. Soldiers know how points are awarded, they know how many points they have, and they know their position in the promotion queue. This promotion information is a critical part of the reenlistment decision, and the services explicitly advise soldiers on their promotion opportunities and steps that would improve their promotion chances.

The promotion results show the importance of controlling for promotion points and history. Some soldiers are high in the queue at the end of their first term and are assured a quick promotion if they reenlist. Other have not yet achieved eligibility for promotion to E5, and these "slow movers" have substantially worse promotion prospects than those in the promotion-eligible queue. The promotion point information captures critical information available to soldiers as they make their retention decisions, and the results show that this information is an important predictor of promotion timing even after adjusting for measured aspects of soldier quality such as the AFQT percentile and educational attainment.

## CONCLUSIONS

The results show that soldiers are quite sensitive to promotion tempo and that promotion could be used to complement military pay and

bonus policies in retaining quality personnel in hard-to-fill skills. We have not demonstrated that the services *should* place more emphasis on promotion, but promotion policy should be an important portion of any compensation package. Unlike pay level and bonuses, promotion policies allow the services flexibility to encourage and reward individual performance by increasing the effective relative pay of high achievers. Pay levels and bonuses help the services attract greater numbers of soldiers, but increases in promotion tempo have the unique feature of attracting both greater numbers and greater quality. Whatever the strengths or weaknesses of the promotion systems, they are the primary policy tool for retaining *quality* personnel.

Finally, we believe that the services should not rely on reduced promotion tempo to induce lower retention during the planned military draw down. Protracted debates over the drawdown could result in stalemate and a default solution in which lower retention targets are met by further declines in promotion tempo. The services should be cognizant of the effect of such a draw down on the quality of the force—a promotion slowdown might succeed in "sweating out" the right numbers of soldiers at the retention point but the "solution" would discourage quality soldiers from joining the career force.

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# 1. INTRODUCTION

Over the last decade, a variety of studies have examined the role of compensation in military retention.[1] For the most part, the policy focus of these studies has been on the effects of military/civilian pay levels and reenlistment bonuses on retention behavior. Although promotion opportunities are another component of compensation policy, promotion has received surprisingly little attention. This oversight is unfortunate for two reasons. First, promotion tempo allows the services flexibility to encourage and reward individual performance by increasing the effective relative pay of high achievers. Holding constant the nominal pay *level* associated with a given paygrade, effective pay is higher for individuals with faster promotion tempo, so that individuals are more likely to stay (other things equal) if their expected promotion time to the next grade is relatively short than if it is long. Second, if promotion tempo does have an important effect on retention, then these retention studies may provide poor forecasts of future reenlistment behavior and misleading predictions of the policy effectiveness of other compensation measures such as pay levels and bonuses.

This study examines the role of promotion opportunities in the retention decision. A joint, integrated model of promotion and retention behavior is developed and estimated. The model is estimated for the Army and the Air Force, and the results are compared with those from previous approaches that use little (if any) promotion information. The proposed model nests earlier approaches as a special case, so comparisons are made for comparable variable specifications and time periods.

The study concentrates on first term reenlistment and promotion to paygrade E5.[2] The first term reenlistment point is a critical decision point for moving enlisted personnel into military careers. Historically, about 40 percent of those soldiers completing their initial term

[1]Roll and Warner (1986) and Hogan and Black (1991) provide reviews of the retention literature.

[2]Paygrade designations are less ambiguous than rank designations when comparing the Army and the Air Force because the same ranks refer to different paygrades in the two services. E4s, E5s, and E6s are specialists fourth class (corporals), sergeants, and staff sergeants, respectively, in the Army and sergeants, staff sergeants, and technical sergeants, respectively, in the Air Force. Promotion to sergeant and staff sergeant connotes different things in the Army and Air Force, so it is less ambiguous to rely on paygrade designations.

have chosen to stay in the military. At the second-term reenlistment point, 70 to 80 percent of soldiers continue on in the military. The most relevant benchmark for soldiers at the end of the first term is their E5 promotion status. Some will have recently achieved E5 status, some are eligible for E5 and have positions in the promotion queue, and some are E4s who have not yet reached eligibility for E5. Promotion status is likely to vary considerably with individual characteristics such as aptitude, proficiency, and interest in the military, but the promotion queue will also reflect demand conditions like overmanned occupations and small enlistment cohorts.

## TRENDS IN PROMOTION TEMPO

A common benchmark for assessing promotion tempo is the average years-in-service at promotion for soldiers promoted within a given fiscal year. Figures 1.1 through 1.3 show how promotion tempo has varied over the past decade. The figures show that the Air Force has consistently promoted personnel slower than has the Army. E4 promotion tempo has varied little for either service, with the Air Force

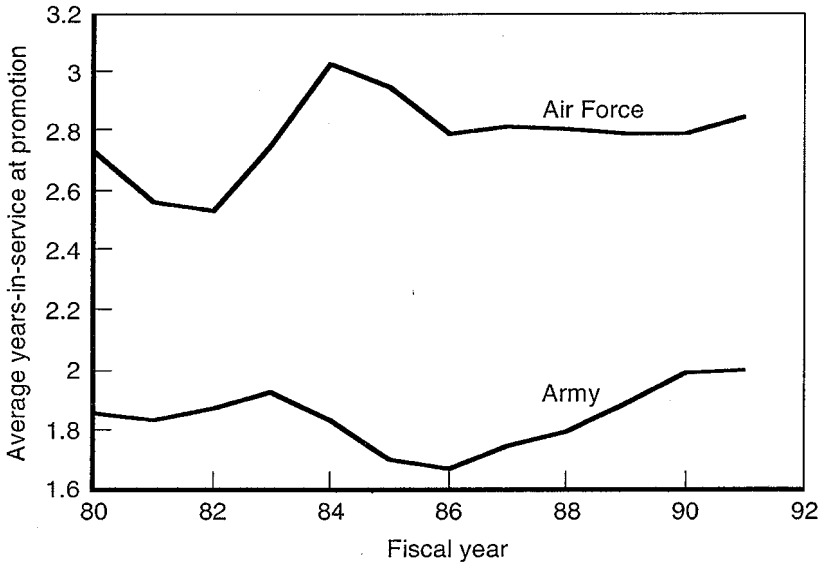


**Figure 1.1—Average Promotion Time for E4**

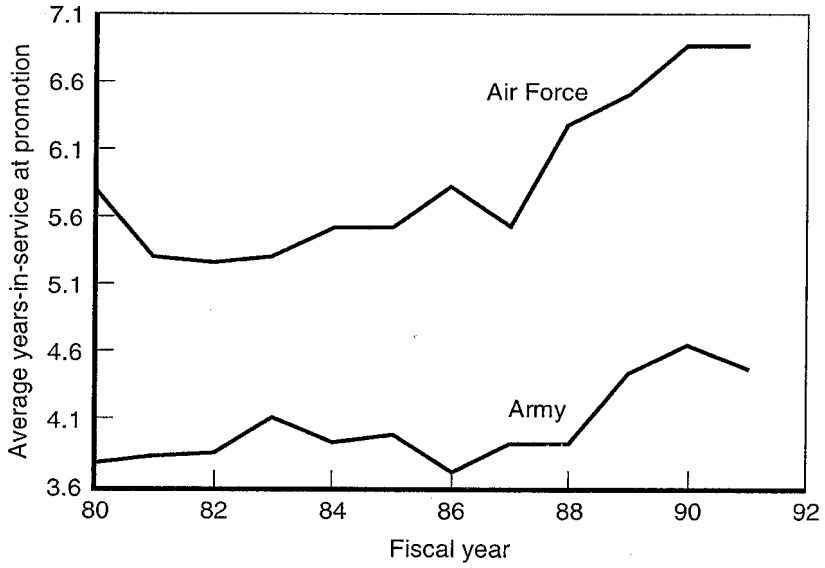


**Figure 1.2—Average Promotion Time for E5**

average virtually constant at about 2.8 years since FY86. E5 promotion tempo was pretty stable through FY86 or FY87, but has risen substantially since then. By FY90, the average E5 promotion tempo was about 20 percent slower than it was in the early 1980s, so that the average soldier was waiting another 9 and 16 months for promotion in the Army and Air Force, respectively. Historically, E6 promotions have typically occurred beyond the completion of the second enlistment term. Figure 1.3 shows that E6 promotion timing has not changed as much on a percentage basis, but that average promotion time has increased by about 11 and 16 months in the Army and Air Force, respectively, between FY87 and FY91.

The reduction in promotion tempo depicted in Figure 1.2 probably understates the reduction in promotion opportunities available to soldiers at the end of their first term. Presumably, some individuals have perceived that they would not reach E5 for some time and have chosen not to reenlist. Other things equal, individuals with relatively shorter expected promotion times are more likely to stay than are those with longer expected promotion times, so changes in average time in service at promotion may understate changes in promotion opportunities.

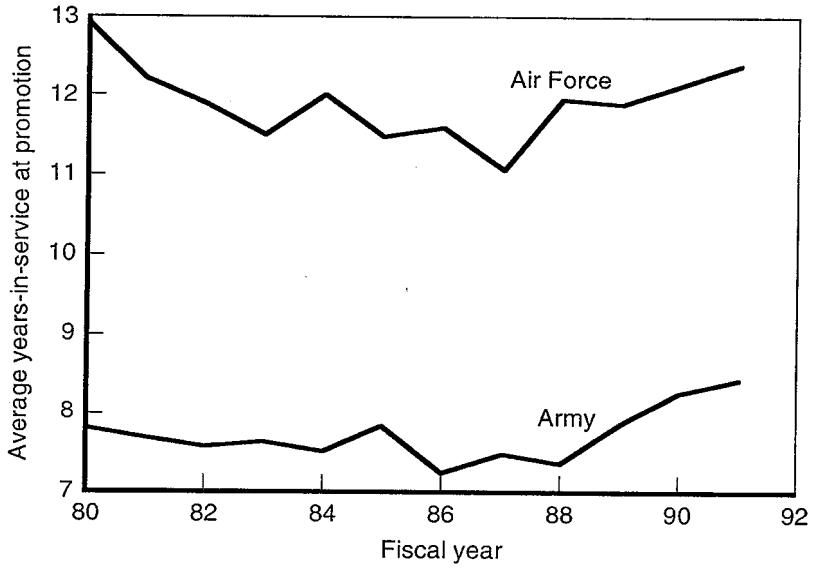


**Figure 1.3—Average Promotion Time for E6**

The recent volatility of E5 promotions reflects several factors. First, protracted congressional budget negotiations have sometimes left the services with fewer authorizations than anticipated. In some years, the Air Force promised promotions before final authorizations were approved, and reduced final authorizations left the Air Force with a large backlog of soldiers awaiting promotion. Second, manpower planners have underpredicted retention levels and overpredicted retirement rates over the last few years, so promotion timing has slowed as more soldiers are competing for few openings.

As the services draw down the size of the enlisted force, it is critical that they consider the potential effects of changes in promotion tempo as well as other compensation components. The large recent swings in promotion tempo suggest that changes in relative pay levels may not be a reliable gauge of military competitiveness vis-à-vis the civilian sector. The promotion slowdown may have altered the quality, number, and skill composition of soldiers reenlisting at the end of the first term. The implications of the recent promotion slowdown have not been examined; rather, the slowdown has been a reaction to events and not a planned phenomenon.

## PROMOTION PHILOSOPHIES

The Army and the Air Force have very different promotion philosophies. The Army essentially promotes to fill vacancies, so that promotion rates vary considerably across occupations. In hard-to-fill specialties with low retention rates, the promotion tempo is high as an incentive to encourage retention. The Air Force system is predicated on equal promotion opportunity, and promotion rates vary little by occupation. The Air Force uses promotion to reward its best airmen irrespective of occupation and then uses other incentives to retrain those airmen in different specialties if overages occur.

The different philosophies produce quite different patterns in promotion tempo across occupations. Table 1.1 shows that E5 promotion tempo varies little by occupation group in the Air Force—the gap between the slowest moving groups (electronic equipment repair and electrical/mechanical equipment repair) and the fastest moving group (medical/dental specialists) is only about six months.[3] In the Army, the promotion times for combat and technical/allied specialists are much shorter than average, and promotion times in functional support/administration and craftsmen areas are much longer than average. The range in average promotion times across occupational areas for the Army is about 14 months.

**Table 1.1**

**Dispersion in Promotion Timing by Occupation (percentage difference from mean in parentheses)**

| Occupational Group | Average Time in Service at Promotion | | | |
|---|---|---|---|---|
| | Army | | Air Force | |
| Infantry, gun crews, seamanship | 4.32 | (–7.30) | 6.78 | (–1.17) |
| Electronic equipment repair | 4.74 | (1.72) | 7.01 | (2.19) |
| Communications/intelligence | 4.53 | (–2.79) | 6.68 | (–2.62) |
| Medical/dental specialists | 4.84 | (3.86) | 6.54 | (–4.66) |
| Other technical/allied specialists | 4.13 | (–11.37) | 6.71 | (–2.19) |
| Functional support/administration | 5.22 | (12.02) | 6.80 | (–0.87) |
| Electrical/mechanical equipment repair | 4.08 | (9.01) | 7.01 | (2.19) |
| Craftsmen | 5.28 | (13.30) | 6.95 | (1.31) |
| Service and supply handlers | 4.81 | (3.23) | 6.83 | (–0.44) |
| Overall | 4.66 | | 6.86 | |

NOTE: Promotion times are in years and are based on FY90 data.

[3]Small differences in average rates across occupations do not necessarily mean that all individuals can expect to be promoted at about the same time. Individual promotion differences are examined in the results sections below.

## INDIVIDUAL PROMOTION OPPORTUNITIES

By the end of the first term, soldiers have acquired considerable information about their individual promotion opportunities relative to the average soldier in their cohort or occupation. Promotion opportunity includes not only the timing of promotion to the next grade but the implication for future promotions as well. Soldiers presumably separate because they anticipate poor promotion prospects—a wait of several years for promotion to E5. Enlisted retention policies restrict the reenlistment of personnel who have not reached a certain paygrade within a designated number of years of service. The current restrictions are seldom binding, however, and few (if any) enlisted personnel are forced to leave because they have not been promoted. In the Army, for example, an E4 can stay in the Army for eight years without reaching the promotion-eligible list for E5. An E4 soldier who is promotion eligible for E5 can remain in the Army for 13 years.[4]

Most soldiers are eligible for E5 by the end of their first term and can anticipate the timing of their promotion. Eligibility means that the soldier has met a minimum set of requirements for promotion to the rank of E5 and competes with other eligibles for promotion to the next grade. Soldiers who are eligible for promotion to E5 are frequently classified as E4(P) or E4 promotable. Eligibility is not a guarantee of or commitment to promotion now or in the future, but it provides the soldier with considerable information about his position in the current promotion pool. Soldiers can anticipate how their promotion points will change and how their position will be affected by new soldiers entering the pool and the promotion of existing promotion-eligible soldiers. A soldier can use his promotion points at the end of the first term to anticipate or predict his E5 promotion time.

Eligible soldiers compete for promotion to E5 on the basis of their promotion points. Points are awarded for a variety of factors such as time in service, time in grade, supervisor ratings, measured skill performance in a military specialty, awards and decorations, and education. These components are assigned weights by the services, and promotion points or scores are computed for all promotion-eligible soldiers. The services inform the soldiers of their points and their po-

[4]Officer retention policies are much more tied to promotion. Officers who are not promoted in a timely fashion are forced to separate. As part of the draw down, the Army has considered placing more restrictions on the retention of enlisted personnel with slow promotion times. Tighter restrictions are controversial because they would "break faith" and force some personnel to leave the service earlier than they had anticipated when making previous reenlistment decisions. In particular, some soldiers who believed that they could stay until retirement would be forced to separate early.

sition in the promotion queue. Promotion cut scores (the number at or above which a soldier is promoted) and average promotion times are readily available to all soldiers and are routinely published in *Army Times* and *Air Force Times.* Soldiers know their points and their position in the promotion queue, as well as the average time to promotion. As part of the reenlistment process, the services advise soldiers on their promotion opportunities and steps that would improve their promotion chances.

A soldier's position on the promotion-eligible list provides considerable information about his promotion prospects. Some soldiers may be near the cut score and recognize that they are virtually assured of a promotion in the next few months. Others may be anticipating an improvement in their score because they are completing an educational program or are sharpening their technical skills. Subsequent promotions may not occur in the exact ordering observed at the end of the first term, but soldiers in the lower quartile of the promotion eligible list probably anticipate slower promotion than do those in the upper quartile.

A unique feature of the database constructed for this study is the availability of promotion point information. Promotion points are a rank ordering of soldiers' positions in the promotion queue and a critical variable for assessing promotion opportunities at the end of the first term.[5] Retention databases have traditionally contained information only on current paygrade and time in grade.[6] Promotion points capture information available to the soldier on his immediate promotion opportunities.

## ORGANIZATION

The next five sections are organized as follows. Section 2 reviews previous enlistment models and proposes a joint model of first-term reenlistment and promotion tempo. Section 3 describes the database

[5]The promotion "queue" for enlisted personnel is a strict ordering of personnel who are currently eligible for promotion. The ordering is not maintained over time, however, since soldiers are reevaluated, new soldiers will become eligible in the future, and some soldiers will choose to leave the military. As a result, a soldier is not guaranteed that he will move up in the pool of eligibles in future time periods. Progress depends on how quickly a soldier accumulates promotion points relative to others in the pool.

[6]The Defense Manpower Data Center (DMDC) maintains an enlisted master record file that includes quarterly snapshot information on individual characteristics including paygrade and time in grade. The DMDC data do not include information on promotion points. This study augmented the DMDC database with promotion point data provided by the Army and the Air Force.

used in the analysis and describes basic overall patterns in reenlistment rates and promotion tempo in recent years. The empirical results for the Army and the Air Force are presented in Sections 4 and 6, respectively. These sections control for broad differences in promotion and retention behavior by occupational areas. More detailed analysis of large occupational areas is reported for the Army and the Air Force in Sections 5 and 7, respectively. Each section addresses the following questions:

- What factors have affected promotion tempo and how have promotion opportunities changed in recent years?
- What is the effect of promotion tempo on retention?
- How do estimated retention equation parameters change after controlling for promotion tempo (that is, is the bias in traditional models important)?

The final section draws together the policy implications of the results. The three appendices provide a detailed description of the econometric and statistical model used in the study and tables on the details of the estimates.

# 2. METHODOLOGY AND ANALYSIS APPROACH

Retention models can be characterized by essentially two groups depending on the specification of the differences in military and civilian opportunities. The traditional approach characterizes opportunities in terms of the military/civilian pay ratio. In recent years, most retention studies have relied on an annualized cost of leaving (ACOL) formulation, where ACOL is an imputation of the net present value of reenlisting. This section provides an overview of these two types of models and proposes a joint model of promotion and retention to augment the pay ratio and ACOL models.[1]

## STANDARD RETENTION MODEL WITH MILITARY/CIVILIAN PAY RATIO

Numerous retention studies (e.g., Lakhani, 1988; Carter et al., 1987; and Hosek and Peterson, 1985) have examined first-term retention as a function of a military/civilian pay ratio, civilian unemployment, military bonuses, and individual demographic characteristics. The primary policy emphasis of these studies has been on the estimation of the effects of military pay and bonuses on retention rates.

For the most part, the studies recognize that the pay ratio variable is not an ideal characterization of the relative opportunities available, but is rather a first approximation of those opportunities. The pay ratio variable would be appropriate under two assumptions. First, the soldiers might be myopic, so that their decisions were based only on information available at the end of their first term. Similarly, soldiers might have poor information about their future prospects, so that they heavily discount these prospects relative to current earnings information. Alternatively, the pay ratio approach is justified if the pay ratio at the end of the first term is a proxy for the ratio of the present values of the military and civilian earnings streams. This assumption may hold at the first-term retention point when the present

[1]This study relies on a partial equilibrium approach to the analysis of retention and promotion behavior. A general equilibrium framework would model both the individual supply-side behavior and the service demand-side behavior simultaneously. The existing retention models have not addressed the demand side of the equation. The partial equilibrium approach assumes that an individual does not anticipate that his retention decision will have a substantial effect on promotion opportunities. In a collective sense, however, all soldiers acting in concert could affect opportunities, so in this sense our model (and previous retention models) are incomplete.

value of the military retirement annuity is small. The military retirement system is unlike most civilian retirement systems in that retirement benefits are "earned" only by completing 20 years of service and then become payable immediately after retirement from the military. This provision is known as "cliff vesting" because benefits are offered if and only if the soldier completes a 20-year military career.[2] As soldiers acquire more and more years of service, the present value of the retirement annuity becomes large, and soldiers may accept low military pay rates (relative to their civilian alternatives) and stay for their retirement annuity.

The pay ratio formulation has two primary advantages over other approaches. First, the pay ratio variable can be readily constructed from military pay tables and published reports of civilian opportunities.[3] Second, the pay ratio approach does not require any assumptions about how wages will change in the future. The ACOL approach is forward looking, but it requires the analyst to anticipate the military and civilian earnings steams for a variety of different types of soldiers.

A potential shortcoming of the pay ratio studies is the omission of control for promotion opportunities available at the end of the first term. The omission may be important because we would expect that soldiers with better opportunities would be more likely to stay and that promotion opportunities would be a good predictor of retention. More important, though, the omission of promotion opportunities may bias the estimates of other effects in the retention specifications.

We suspect that the omission of promotion information in the standard formulation reflects the unavailability of suitable information and not a judgment of the researchers that such information was unnecessary or inappropriate. DMDC, the primary data source for the pay ratio studies, does not maintain the detailed promotion point information that was utilized in our study. DMDC promotion information is limited to the average time in grade and time in service at promotion. These average promotion times could have been used in the pay ratio models as crude adjustments for promotion opportunities, but we are not aware of any pay ratio study that has done so. In

[2]In civilian retirement plans, retirement benefits are partially vested during the first few years of employment and become fully vested thereafter. The vesting rules for civilian employers are restricted by federal regulations.

[3]Hosek et al. (1992) show the importance of using a pay ratio that reflects the demographic structure of the military. Average civilian earnings may not be a good indication of the opportunities available to young military soldiers at the end of their first term.

their retention study, Hosek and Peterson (1985) recommended that DMDC collect more information on promotion opportunities for inclusion in future studies.

## ACOL RETENTION MODEL

Much of the retention work over the last decade owes its roots to the ACOL formulation of relative military/civilian pay opportunities (Warner, 1979; Enns et al., 1984; Warner and Goldberg, 1984). The military/civilian pay ratio is replaced in this approach by the so-called ACOL variable, which is an elaborate index function representing the net present value of reenlisting. The approach is forward looking in that the reenlistment decision is evaluated not only on relative current earnings but on the net effect of staying on future military/civilian earnings opportunities. The approach also explicitly incorporates the present value of the military retirement annuity in the current stay/leave decision.

The theoretical merits of the ACOL model have been debated elsewhere,[4] but whatever the theoretical merits of the approach, the ACOL formulation is dependent on the prediction of the life-cycle earnings of soldiers in military and civilian alternatives. Few databases contain detailed information on post-service earnings opportunities of military personnel. Even with appropriate data, however, it is not clear whether the current civilian earnings of a 15-year veteran are a reasonable prediction of the future opportunities of a current soldier. Furthermore, the civilian earnings recorded for soldiers who leave may overstate the civilian opportunities available precisely because those soldiers with better opportunities self-select into the civilian sector.

Even without the problem of veteran earnings, however, projecting youth earnings is no simple task. ACOL requires an earnings projection 15 to 20 years into the future at a time when the nature of the American economy is changing dramatically. Youth wages are particularly sensitive to changes in economic conditions, and several studies have shown the sensitivity of youth wages to cohort size and composition (Tan and Ward, 1985; Welch 1979).

[4]The development and application of the ACOL model are discussed in detail in Warner and Goldberg (1984) and Smith et al. (1991). Fernandez et al. (1985) and Gotz and McCall (1984) provide criticisms of the theoretical foundations of the ACOL approach. Stock and Wise (1990) provide strong theoretical foundations for an ACOL-like model of civilian retirement.

Most ACOL formulations have done little to adjust for differences in military promotion opportunities. Future military earnings are based on average promotion times—a soldier observes the average time to promotion for E5 through E9 and computes his military earnings profile from these averages. Average promotion times have two problems. First, they are averaged only over those individuals who reach those paygrades. We suspect that many soldiers leave the service *because* they have poor promotion opportunities, so that the average promotion time of the survivors may underestimate the expected promotion opportunities of those making the retention decision. Second, by the end of the first term, soldiers have received substantial amounts of information on whether they should expect "average" promotion time. They know exactly where they stand in the promotion queue, and retention decisions are affected by individual promotion opportunities.

Smith et al. (1991) develop an elaborate specification of the ACOL retention model. The authors impute expected promotion times and control for the censoring bias with survival techniques similar to those of this study. Their approach suffers from two shortcomings, however. First, their promotion equation does not include information on promotion points or soldier position in the promotion queue. Our results (see Sections 4 through 7) suggest that this information is quite important in predicting promotion timing. Second, the retention results are biased because the model includes a relative paygrade variable that shows whether the soldier's current grade is above that of his cohort.[5] This variable incorporates information on individual promotion history, but a simultaneous equation bias occurs because unmeasured factors that affect a soldier's current grade will also affect retention.[6]

A dynamic programming approach has been suggested as an alternative approach for incorporating future earnings into modeling the retention decision. Individual decisions are based on uncertainty about future earnings opportunities and reflect optimization over the range

[5]This relative paygrade variable is used in several of the ACOL-based studies (Daula and Baldwin, 1986; Daula and Moffitt, 1991; and Warner and Solon, 1991).

[6]Our approach replaces the relative paygrade indicator with a continuous variable representing the expected time to E5 at the end of the first term. A priori, expected promotion timing is a better indication of recruit heterogeneity at the end of the first term than is the discrete relative paygrade variable, because the continuous variable contains more information than does the discrete relative paygrade variable. Our approach also avoids the simultaneity bias by using an instrumental variable technique. A potential pitfall of our approach (discussed below) is that promotion points may themselves be an endogenous variable.

of likely outcomes. Daula and Moffitt (1991) have estimated a dynamic programming model of Army retention behavior and have shown that the results are similar to those of the ACOL formulation. Gotz and McCall (1984) estimated a dynamic programming model for Air Force officers and argue that the model is more appropriate than the ACOL approach.[7]

Like the ACOL model, the dynamic programming models have not used information on individual promotion opportunities. The models may better account for the range of uncertainty about future opportunities, but they do not account for the promotion point information that is readily available to soldiers at the end of their first terms.

## JOINT MODEL OF PROMOTION AND RETENTION

We believe that promotion opportunities at the end of the first term may have an important bearing on the reenlistment decision and that these opportunities should be better accounted for in existing retention models. We propose a procedure for augmenting the pay ratio and ACOL models with information on expected E5 promotion time.[8] The goal is to estimate individual promotion opportunities at the end of the first term, to assess whether the promotion opportunities affect the retention decision, and to determine whether other retention factors are affected by the adjustment for promotion opportunities. The remainder of this section describes the approach, and Appendix A details the econometric formulation of the model.

The first step is to estimate promotion opportunities at the end of the first term. Each soldier has some expectation about how long it will take to reach E5. Expected promotion time is probably a function of measured factors like aptitude scores and education. The soldier will also know his promotion status or where he stands in the promotion queue. Some soldiers will be near the appropriate promotion cut score and know with near certainty that they will be promoted quickly if they reenlist. Others have not yet have reached eligibility for E5 promotion and will know that their promotion will be many months in the future.

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[7]Similar models are used in the analysis of civilian retirement decisions (Rust, 1989; Stock and Wise, 1990). Stock and Wise provide a useful comparison of the merits of the dynamic programming and ACOL-type approach.

[8]We have not estimated a dynamic programming model, but we suspect that the results from the other models will provide a strong indication whether the extra promotion information would improve the performance of the dynamic model as well.

Actual promotion times are unobserved (censored) for some soldiers, because they leave the service without reaching E5 or because they have not yet reached E5 at the end of our 1990 observation period. This censoring introduces a bias into the estimation of expected promotion times, because many of those with long promotion times will choose to leave early (i.e., the survivors are not representative of all soldiers making retention decisions). A survival model is used to estimate expected E5 promotion time and adjust for the tendency of soldiers with long expected promotion times to leave the service at the end of their first terms.

Expected promotion time $(y_1^*)$ is modeled as a function of observed variables (a column vector x) that includes individual soldier characteristics, indicator variables for cohort and occupational group, and promotion point information at the end for the first term; a row vector of unobserved parameters $(\beta_1)$; and an unobserved random error $(\varepsilon_1)$:[9]

$$y_1^* = \beta_1 x + \varepsilon_1 \quad . \tag{2.1}$$

Actual promotion time is observed only if the soldier has been promoted during our observation period, that is, the soldier's promotion time is less than or equal to the amount of time the soldier has spent in the service (T). The observations are divided into two groups depending on whether promotion time is observed or unobserved (censored).[10] For censored observations, their promotion time must be greater than their time in service at the time of separation from the military or the end of our 1990 observation period. The log likelihood function for the model is specified as

$$L = \prod_1 \frac{1}{\sigma_1} \phi_1\left(\frac{y_i^* - \beta_1 x}{\sigma_1}\right) \cdot \prod_2 \left[1 - \Phi_1\left(\frac{T - \beta_1 x}{\sigma_1}\right)\right] \tag{2.2}$$

where $\phi_1$ and $\Phi_1$ are the univariate normal density and cumulative functions, respectively, $\sigma_1$ is the standard deviation of $\varepsilon_1$, and the

[9]In the presentation of the model, the individual observation subscript has been omitted for notational clarity.

[10]If promotion timing was considered separately from retention, then expected E5 promotion time could be estimated by a single equation limited dependent variable technique or the equivalent survival technique (Maddala, 1983; Amemiya, 1979; Nelson and Olson, 1978). Our formulation is more complicated, because promotion timing is an endogenous variable affecting retention.

products over numbered data regimes are 1 if $y_1^* \leq T$ and 2 if $y_1^* > T$. Maximization of the function produces estimates of $\beta_1$ and $\sigma_1$.

The pay ratio and ACOL retention models are estimated with the inclusion of a variable representing expected E5 promotion time at the end of the first term. If we let $y_2^*$ measure the individual's propensity to reenlist, then the retention equation is

$$y_2^* = \beta_2 x + \gamma y_1^* + \varepsilon_2 \quad , \tag{2.3}$$

where $\varepsilon_2$ is a normally distributed error term with mean zero and variance 1. The propensity to reenlist is a latent variable, and the observed outcome is reenlist if $y_2^* > 0$ and not reenlist otherwise. Holding constant other factors, we expect that individuals with better promotion opportunities will be more likely to reenlist than those with poor promotion prospects, so that $\gamma < 0$. In principle, promotion prospects are already embedded in the ACOL model through changes in average promotion rates across cohorts. It remains an open question, however, whether information on individual promotion opportunities will improve the retention estimates in the ACOL formulation.[11]

The joint promotion and retention model is estimated with a simultaneous equation approach that allows for an error term correlation between the promotion and retention equations. A priori, it is likely that unobserved factors like individual job match or satisfaction with the military will affect both expected promotion time and retention. Soldiers whose actual promotion times are shorter than predicted from their observed characteristics are likely to have retention rates higher than predicted, because these soldiers are better matched with the military and more interested in pursuing a military career.

In our analysis, we have used two approaches for incorporating the promotion timing information into the ACOL regression specification. First, the joint promotion and retention version of ACOL examines whether expected individual promotion time adds anything to the retention prediction over and above the ACOL adjustment for average promotion time. An alternative approach recomputes the ACOL variable with the additional information on expected promotion time. The retention specification is then reestimated with the revised ACOL variable, and the parameter estimates are compared with those of the other specifications. This approach preserves the parsi-

[11]An alternative specification is also estimated in which ACOL is recomputed based on expected promotion time at the end of the first term.

mony of the ACOL approach and monetizes the effects of the differences in promotion timing in the ACOL variable.

An econometric complication associated with our estimation strategy is the possibility that promotion points are an endogenous variable in the promotion timing equation. The endogeneity of promotion points might occur because points are affected by transient factors associated with soldier effort and "taste" for the military. Suppose that "true" promotion points are a measure of soldier performance and skill, but that measured points include some measurement errors. The model is then expanded to include a promotion points' equation of the form:

$$y_0 = \beta_0 \, z + \varepsilon_0 \tag{2.4}$$

where $y_0$ is measured promotion points, $\beta_0$ is a row vector of unobserved parameters, z is a set of exogenous factors that affect all promotions, and $\varepsilon_0$ is an unobserved random disturbance. The problem ultimately lies in the fact that information on the variables in z is not available. The endogeneity of promotion points will not affect parameter estimation of timing equation if $\varepsilon_0$ and $\varepsilon_1$ are uncorrelated, since in that case $y_0$ will be uncorrelated with $\varepsilon_1$. If this is not the case, however, the parameter estimates in the promotion timing equation are biased and the retention parameter estimates are biased through the affect of $y_1^*$ on retention (Greene, 1990). Omitting $y_0$ from the timing equation has its own pitfalls, which can be seen when we substitute Eq. (2.4) into the timing equation and solve for the reduced form:

$$y_1^* = \beta_1 \, x + \gamma_1 y_0 + \varepsilon_1 = \beta_1 \, x + \gamma_1 y_0 + \left(\gamma_1 \varepsilon_0 + \varepsilon_1\right) . \tag{2.5}$$

Although the compound disturbance in Eq. (2.5) is not a problem, regression of $y_1^*$ on x *without* z would produce biased estimates of $\beta_1$ whenever x and z are not orthogonal (that is, do not have zero sample correlation). Orthogonality would be an exceptional case, as the vectors x and z are likely to contain common elements. Faced with the choice of endogeneity bias or omitted variable bias, we chose to include $y_0$ for several reasons. First, promotion points are likely to contain critical information on soldier performance that is not incorporated in other variables in the model. Although entrance characteristics like Armed Forces Qualification Test (AFQT) score and education are associated with military performance, we expect that promotion points include additional, unmeasured aspects of military performance. Second, McCallum (1972) and Wickens (1972) have

shown that the minimum asymptotic coefficient bias is smaller when a relevant proxy variable is included in a multiple regression model than when the proxy is excluded. Finally, Aigner (1974) shows that in most circumstances the inclusion of the proxy variable is also recommended on a mean-squared error criterion.

# 3. DATABASE

The analysis database consists of information on soldiers completing their first enlistment during FY83 through FY89. The analysis is restricted to male enlistees with four-year enlistment terms. Women have received differential consideration in recent retention studies. Several studies have restricted themselves to males only (Warner and Solon, 1991; Hosek and Peterson, 1985; and Ward and Tan, 1985), others have pooled across gender groups (Boesel and Johnson, 1988; Carter et al., 1987), and another study has estimated separate models by gender (Smith et al., 1991). This study concentrates on promotion tempo and retention in the larger group of male enlistees, but the model could be readily reestimated for women as well.[1]

The focus on four-year enlistees is not restrictive in the Air Force, since about 85 percent of airmen enlist for four-year terms and the remaining six-year enlistees are concentrated in a few occupations with special training requirements. Three-year enlistees constituted about 55 percent of Army accessions through FY86, but the primary Army enlistment term was four years in FY87. By FY88, two-thirds of new accessions were for four-year terms. The analysis focus on four-year enlistees for the Army is dictated by the facts that this is the most relevant group for predicting the behavior of most soldiers, the four-year group is more directly comparable with their Air Force counterparts, and the four-year group has substantially more information on E5 promotion opportunities than does the three-year group.[2]

The study examines soldiers who are completing their first term of service and ignores first-term attrition. A recent study (Warner and Solon, 1991) estimated a joint model of first-term attrition and retention. Retention results potentially could be biased because soldiers who are relatively unlikely to reenlist may self-select before the retention point by leaving before the end of their enlistment term. Warner and Solon estimated a simultaneous equation model of first-

[1]A careful reestimation of the model would require thorough attention to possible specification differences between men and women.

[2]At the end of their first term, many three-year enlistees have not fulfilled the minimum time in grade and time in service requirements for promotion to E5. The normal Army requirement for E5 is 8 months time in grade as an E4 and 36 months time in service. Both these restrictions can be waived for highly qualified soldiers, but most three-year enlistees are unable to qualify for E5 promotion by the end of their first term.

term completion (survival) and retention. They found that the residuals in the survival and retention specifications were not significantly correlated and that the parameter estimates in the retention equation were not significantly altered by the inclusion of the attrition information. Given their results, we have followed the traditional approach in retention analysis and concentrated on soldiers who successfully complete their first term.

The primary data source is the enlisted master/loss records maintained by DMDC. The DMDC records provide individual characteristics at the time of accession, a snapshot of characteristics during each respective quarter on active duty, and a loss record of characteristics for those soldiers separating from active-duty service.

Our analysis required a special, longitudinal tracking of individuals to construct their promotion history. Master/loss records contain information only on the soldier's current grade and time in grade. The promotion history file was created so we could determine whether soldiers who were promoted quickly at earlier grades also had quicker promotion times for their current grade.

A critical promotion variable that is not available from DMDC data is promotion points. In both the Army and the Air Force, E5 promotions are based on accumulated promotion points. Points are awarded for time in service, time in grade, supervisor ratings, skill test performance, and military awards. Promotion point information was provided by the Army and the Air Force, so we could determine where an individual soldier was positioned in the promotion queue.

The promotion point information maintained by the services is less than ideal for research purposes. The Army provided records of promotion points by quarter, but the records did not identify soldier specialty or the promotion cut score. Army soldiers compete for promotions within their specialties, so the score information was relevant only when compared with the appropriate specialty-specific group. The score information was merged back with DMDC information on specialty assignment, and a standardized score was created for each soldier within his specialty.[3]

The Air Force maintains comprehensive promotion information as part of the Weighted Airman Promotion System (WAPS). WAPS

[3]For each promotion time period, average scores and deviations from the average were computed by specialty for all soldiers eligible for promotion to E5. The standardized score was computed by differencing the individual score from the specialty average and dividing the difference by the standard deviation.

tapes were provided for the promotion boards for FY83 through FY89. The WAPS information includes promotion score, specialty, and cut score as well as a breakdown of the components that constitute the promotion score.

The remainder of this section provides an overview of how first-term promotion and retention rates have varied over recent cohorts and across occupational areas. The description of patterns in these key variables is background for the more detailed, multivariate analyses of the next two sections.

## OVERVIEW OF ARMY PROMOTION AND RETENTION PATTERNS

Table 3.1 shows how several key Army reenlistment variables have changed over recent years. The table reflects the characteristics of the year-group that makes decisions in each respective year. The military pay component is based on the average annual basic military compensation (BMC) for an E4 soldier with over three years of service.[4] Civilian earnings are based on annual Current Population Survey (CPS) earnings for the appropriate age, education, and race group.

Perhaps the most striking pattern in Table 3.1 is the marked improvement in the quality of soldiers reaching the reenlistment point.

**Table 3.1**

**Trends in Army Retention and Promotion Variables**

| Fiscal Year | Military/ Civilian Pay Ratio | Retention | High-Quality Soldiers | Promoted to E5 | Promotion Eligible |
|---|---|---|---|---|---|
| 83 | 1.14 | 42.5 | 26.9 | 33.6 | 13.5 |
| 84 | 1.13 | 37.7 | 31.9 | 33.9 | 13.7 |
| 85 | 1.09 | 39.9 | 42.3 | 32.8 | 22.3 |
| 86 | 1.12 | 41.0 | 48.1 | 33.9 | 24.6 |
| 87 | 1.13 | 40.9 | 56.1 | 34.1 | 25.6 |
| 88 | 1.09 | 42.4 | 64.0 | 30.7 | 23.9 |
| 89 | 1.04 | 48.8 | 72.5 | 22.8 | 31.8 |

[4]The military component reflects changes in the level of military pay over time and does not include the higher earnings of those individuals who have already been promoted to E5 by the end of their first term.

In recent years, the services have been very successful in attracting high-quality soldiers (those who have high school diplomas and who score above the 50th percentile on the AFQT). The quality of entering cohorts improved dramatically, and this quality is reflected in the quality of the cohorts making reenlistment decisions.[5] The high-quality group grew from 27 percent in FY83 to 73 percent in FY89.

Table 3.1 shows a 10 percent decline in relative military/civilian pay over the period FY83 to FY89.[6] This comparison is very sensitive to the quality mix that is the basis of the pay comparison. Low-quality soldiers have substantially poorer civilian alternatives than do high-quality soldiers, primarily because high school graduates earn a substantial earnings premium relative to nongraduates. The fewer civilian alternatives for nongraduates means that *within* each cohort, the military/civilian pay ratio is much greater for low- than for high-quality soldiers. The relative earnings of high-quality soldiers actually rose about 4 percentage points over the seven-year period, but the overall trend was downward because the later cohorts contained so few low-quality soldiers.

The average retention rate over the seven-year period was about 42 percent, but the rate reached about 49 percent in FY89. The retention rates do not track closely with the military/civilian earnings ratio. In part, this tracking problem reflects the different quality mix of the cohorts, and the multivariate model should help sort out the underlying relationship between relative pay and retention.

The promotion variables in Table 3.1 indicate how first-term promotion opportunities have declined in recent years. About a third of the FY83 retention cohort had reached E5 by the end of the first term, but the FY89 cohort contained only about 23 percent at the E5 level. The cohort share that is eligible for promotion to E5 has risen from 13 to 32 percent over the seven-year period. The share of soldiers who have not yet reached promotion eligibility is relatively stable over time, so that the growth in the promotion-eligible category largely offsets the decline in the share of soldiers promoted to E5. In summary, the share of soldiers attaining promotion eligibility status has in-

[5]High-quality soldiers have much lower first-term attrition than do low-quality soldiers, so the quality marks for the respective retention cohorts *net of attrition* are even better than for the corresponding accession cohorts (Buddin, 1988).

[6]Hosek et al. (1992) examine alternative measures of military/civilian pay and track the measures against manpower trends in accessions and retention. The pay variable used here is similar to that in their study, in that civilian earnings are based on youth earnings and not on overall civilian earnings. They concentrate on aggregate patterns, however, and look at the ratios in the growth rates of military and civilian pay.

creased, but the promotion rates for E5 have declined, so the promotion eligible pool has grown.[7]

Table 3.1 also indicates that E5 promotion opportunities vary considerably across soldiers. Some soldiers have already been promoted, but about half of the soldiers have not yet achieved eligibility for E5. Promotion-eligible soldiers know their points and their position in the promotion queue, so they can anticipate the timing of their E5 promotion. Similarly, ineligible soldiers can anticipate what steps are required to achieve eligibility and how long they would then remain in the promotion queue.

The overall picture from Table 3.1 is somewhat anomalous. Retention levels and soldier quality are high by historical levels, but promotion rates and military/civilian pay are historically low. The substantial decline in promotion tempo suggests that the nominal pay ratio (holding constant military pay level) substantially overstates the effective military/civilian pay ratio, which takes promotion opportunity into account.

Table 3.2 shows that retention rates, percent high quality, and promotion status vary considerably across occupational groups. Retention rates have been low in the infantry, electronic equipment repair, and craftsmen areas, and highest in the functional support/administration area. The chances of E5 promotion are much higher in in-

**Table 3.2**

**Army Occupational Differences in Promotion and Retention**

| Occupational Group | Retention | High-Quality | Promoted to E5 | Promotion Eligible |
|---|---|---|---|---|
| Infantry, gun crews, seamanship | 39.7 | 58.9 | 42.6 | 18.9 |
| Electronic equipment repair | 35.0 | 70.3 | 25.3 | 24.5 |
| Communications/intelligence | 44.3 | 69.8 | 43.6 | 22.1 |
| Medical/dental specialists | 47.0 | 57.1 | 20.5 | 32.3 |
| Other technical/allied specialists | 46.7 | 59.5 | 33.8 | 22.0 |
| Functional support/administration | 53.5 | 46.8 | 20.5 | 32.9 |
| Electrical/mechanical equipment repair | 43.5 | 29.1 | 20.9 | 24.5 |
| Craftsmen | 33.4 | 26.0 | 17.5 | 20.6 |
| Service and supply handlers | 52.4 | 66.2 | 23.3 | 26.8 |

[7]Promotion rates refer to the share of promotion-eligible soldiers selected from the promotion pool in a given time period.

fantry and communication/intelligence areas than in most other skills—43 percent of combat soldiers reach E5 in the first term as compared with only 17 percent of soldiers in craftsmen specialties. The quality marks also differ substantially by occupational area, with fewer than 30 percent of the seats in the electrical/mechanical equipment and craftsmen areas filled by high-quality soldiers.

## OVERVIEW OF AIR FORCE PROMOTION AND RETENTION PATTERNS

Table 3.3 describes recent trends in key Air Force retention and promotion variables. In the Air Force, 53 percent of the FY83 retention cohort were high quality, as compared with 70 percent in FY89. The military/civilian pay ratio is virtually flat over the seven-year period, in part because Air Force quality marks were already high in FY83 and did not improve as much as in the Army. Another reason for the flat pay profile is that the Air Force retention cohorts contain very few nongraduates (0.3 percent), who have low civilian opportunities. Over this period, the Army averaged 4 percent nongraduates, but the share of nongraduates declined from 9 percent in FY83 to 1 percent in FY89.

Air Force retention rates varied considerably by cohort. The rate rose 8 percentage points in FY87, fell 12 percentage points in FY88, and then rose 13 percentage points in FY89. These large retention swings occurred while the military/civilian pay ratio was virtually unchanged. Apparently, either Air Force opportunities differed markedly for the respective cohorts, or the Air Force imposed severe demand restrictions on first-term reenlistment in some of the cohorts.

**Table 3.3**

**Trends in Air Force Retention and Promotion Variables**

| Fiscal Year | Military/ Civilian Pay Ratio | Retention | High-Quality Soldiers | Promoted to E5 | Promotion Eligible |
|---|---|---|---|---|---|
| 83 | 1.05 | 51.4 | 53.2 | 7.4 | 54.8 |
| 84 | 1.05 | 52.4 | 52.0 | 8.9 | 49.3 |
| 85 | 1.03 | 46.0 | 56.5 | 9.2 | 37.4 |
| 86 | 1.03 | 49.7 | 58.6 | 8.2 | 58.8 |
| 87 | 1.02 | 57.9 | 66.2 | 8.0 | 57.4 |
| 88 | 1.04 | 45.7 | 69.7 | 5.7 | 35.3 |
| 89 | 1.05 | 58.2 | 70.6 | 4.7 | 64.5 |

Unlike in the Army, few first-termers have reached E5 by the end of their initial term. On average, about 8 percent of the airmen have reached E5, but E5 promotions fell from 9.2 percent in FY85 to 4.7 percent in FY89.

Although few airmen have been promoted to E5 at the end of their term, most are promotion eligible and have WAPS scores that designate their current position in the E5 promotion queue. The Air Force notifies airmen of their scores on each WAPS component as well as their total score and the total required for promotion. The Air Force considers visibility to be a primary feature of WAPS, because airmen know where they stand and can assess what steps are needed to improve their promotion prospects. Knowledge of their WAPS score and the corresponding cut score for E5 promotion allows soldiers to anticipate the timing of their promotion.[8]

An airman's WAPS position will change from cycle to cycle, but these changes will occur in a relatively predictable manner. First, promoted airmen will leave the promotion eligible pool, so airmen who are not selected for promotion will tend to move up in the next cycle because they are no longer competing against those airmen promoted in the current cycle. Second, new airmen will become eligible in the next cycle. Finally, an airman may score differently on the skill test or receive different supervisor ratings in the future. Of course, airmen are guaranteed increased WAPS points for time in service and time in grade in future cycles.

Retention rates and soldier quality differ somewhat across Air Force occupations. Table 3.4 shows that retention rates range from 62 percent in the functional support and administration specialties to only 41 percent in the electronic equipment repair area. Low-quality soldiers are concentrated in the electrical/mechanical repair and craftsmen specialties.[9] Nearly 90 percent of the soldiers in electronics repair specialties are high quality.

Unlike the Army, the Air Force policy limits the variation in promotion rates by occupation, but Table 3.4 shows that promotion rates do vary substantially with specialty at the end of the first term. The Air Force policy is to promote quality soldiers first, irrespective of spe-

[8]The Air Force has two promotion cycles per year for E5 promotions. The Air Force is missing the WAPS files for the 85B and 88B cycles, which explains why relatively few soldiers are observed with WAPS scores in these cohorts.

[9]In the Air Force, the infantry/combat arms area consists primarily of installation security specialists.

**Table 3.4**

**Air Force Occupational Differences in Promotion and Retention**

| Occupation Group | Retention | High-Quality | Promoted to E5 | Promotion Eligible |
|---|---|---|---|---|
| Infantry, gun crews, seamanship | 48.8 | 52.8 | 8.8 | 52.7 |
| Electronic equipment repair | 41.0 | 88.7 | 9.2 | 49.3 |
| Communications/intelligence | 50.2 | 77.8 | 11.0 | 51.5 |
| Medical/dental specialists | 52.0 | 75.3 | 5.4 | 49.3 |
| Other technical/allied specialists | 47.8 | 68.8 | 10.1 | 49.7 |
| Functional support/administration | 62.2 | 58.3 | 7.4 | 52.2 |
| Electrical/mechanical equipment | 50.7 | 49.0 | 7.2 | 46.1 |
| Craftsmen | 48.4 | 49.4 | 5.5 | 48.6 |
| Service and supply handlers | 52.6 | 52.9 | 5.4 | 50.0 |

cialty, although there is some flexibility for slightly faster promotion in some hard-to-fill specialties.[10] About 10 percent of airmen in the communications/intelligence and other technical/allied specialist areas have reached E5, as compared with about 5 percent of the airmen in the medical/dental, craftsmen, and service and supply handlers areas.

About 49 percent of the airmen in each area have promotion points and are in the promotion queue for E5. Unlike actual promotions, the chances of an airman being in the E5 promotion queue at the end of the first term do not vary much by occupational area.

[10]Within a promotion cycle, the Air Force allows the promotion rates for a group of chronic critical shortage (CCS) specialties to be five percentage points higher than those for non-CCS specialties.

# 4. PROMOTION AND RETENTION RESULTS FOR THE ARMY

This section reports the empirical results for the Army. The section is divided into three parts. The first looks at factors that affect the timing of promotion to E5. The second part examines a retention model based on military/civilian pay. The results from a standard regression specification are compared with those from the joint model of promotion and retention. The final subsection examines the sensitivity of an ACOL retention model to the inclusion of promotion timing information.

This section controls for broad occupational differences in promotion and retention rates. The results show the overall summary pattern of promotion and retention behavior for all occupations. The next section examines promotion and retention behavior within three occupational areas. The area-specific analysis determines whether factors affecting promotion and retention differ substantially across skill areas.

## PROMOTION TIMING

Table 4.1 describes the regression results for the promotion portion of the promotion and retention model. The table reports specifications with and without the promotion point information. Both specifications are adjusted for the fact that some observations are censored because the soldier left the service before reaching E5 or had not yet reached E5 at the time the data were collected. The censoring-adjusted coefficients reflect the promotion opportunities available to soldiers. The size of the censoring bias is substantial in that the average time to E5 for those soldiers already promoted by the first-term retention point is about 37 months and the average overall predicted promotion time is about 54 months. This result reinforces the suggestion from Table 3.1 that E5 promotion opportunities vary considerably across soldiers. Many of those promoted to E5 during the first term are recognized overachievers who are promoted in the secondary zone, that is, the Army waived the normal time-in-service requirement of 36 months for E5 promotion. Many of those not yet promoted have poor prospects for promotion in the near future.

**Table 4.1**

**Estimated Regression Coefficients for Expected Time to E5 (standard errors in parentheses)**

| Variable | Basic Model | | Adds Promotion Points | |
|---|---|---|---|---|
| Intercept | 3.5806* | (0.0158) | 2.9431* | (0.0257) |
| Cohort Group: | | | | |
| FY84 | 0.0055 | (0.0128) | –0.0625* | (0.0122) |
| FY85 | 0.0247 | (0.0131) | –0.0281* | (0.0127) |
| FY86 | 0.0744* | (0.0127) | 0.0519* | (0.0126) |
| FY87 | 0.0565* | (0.0126) | 0.0280* | (0.0126) |
| FY88 | 0.0962* | (0.0129) | 0.0774* | (0.0128) |
| FY89 | 0.1712* | (0.0133) | 0.1220* | (0.0132) |
| Occupational Group: | | | | |
| Electronic equipment | 0.1485* | (0.0134) | 0.0821* | (0.0120) |
| Communications/intelligence | 0.0148 | (0.0096) | 0.0068 | (0.0085) |
| Medical/dental | 0.2104* | (0.0191) | 0.1655* | (0.0173) |
| Other technical/allied | 0.1413* | (0.0243) | 0.0901* | (0.0216) |
| Functional support/administration | 0.1888* | (0.0142) | 0.1612* | (0.0128) |
| Electrical/mechanical | 0.1378* | (0.0088) | 0.0995* | (0.0079) |
| Craftsmen | 0.2028* | (0.0154) | 0.1419* | (0.0142) |
| Service/supply handlers | 0.1212* | (0.0251) | 0.1088* | (0.0226) |
| General Educational Development certificate | 0.0177 | (0.0230) | 0.0235 | (0.0207) |
| Non-high-school graduate | 0.1611* | (0.0204) | 0.0980* | (0.0189) |
| Some post-secondary school | –0.0741* | (0.0189) | –0.0387* | (0.0168) |
| AFQT score | –0.0026* | (0.0001) | –0.0016* | (0.0001) |
| Time to E4 | 0.0172* | (0.0004) | 0.0110* | (0.0004) |
| Time to E4(P) | — | — | 0.0193* | (0.0005) |
| Not yet E4(P) | — | — | 0.1315* | (0.0067) |
| Promotion point score | — | — | –0.0472* | (0.0040) |
| Log likelihood | –4548.2 | | –2601.2 | |

NOTE: The omitted reference group is high school graduates in an infantry/combat specialty in the FY83 retention cohort. Promotion time (time in service at promotion) is measured in natural logarithms. Entries with asterisks are significant at the $\alpha = 0.05$ confidence level. E4(P) refers to E4 promotable—promotion eligible for E5.

The coefficients in the two specifications have slightly different interpretations. The basic model without promotion points indicates how quickly particular types of individuals are promoted, and the expanded model with promotion points describes how particular variables affect promotion timing *conditional* on promotion points.

The substantial improvement in the log likelihood after including promotion points is an indication that the promotion information is providing unique new information on promotion timing. The promotion history and score information capture a dimension of soldier

quality over and above their observed entry characteristics. Soldiers who achieve high promotion scores and are promoted quickly may be inherently better suited to the military, better motivated, or more skilled. Over the first term, supervisors acquire more information on individual performance, and this information is reflected, albeit imperfectly, in the promotion history and score information.

### Cohort

Cohort differences in promotion tempo reflect a variety of supply and demand factors. In some years, authorizations may change so that fewer promotion opportunities exist. In other years, retention may be unusually strong, so that promotion opportunities are retarded because more soldiers are competing for the same number of E5 authorizations. The cohort variables show the net effects of the supply and demand interactions after controlling for other characteristics.

The cohort variables in the basic specification show that, on net, E5 promotion opportunities have fallen substantially since FY83. Other things equal, a soldier in the FY89 retention cycle could expect to wait about 17 percent (ten months) longer than a similar soldier in the FY83 cycle. Promotion tempo was pretty stable from FY83 through FY85, fell by about 7 percentage points for the period from FY86 through FY88, and fell sharply in FY89.

The results from the second equation suggest that even controlling for a soldier's current position in the promotion queue, there were substantial differences in how quickly soldiers were likely to proceed to E5. Given relative position in the promotion queue at reenlistment, soldiers in the FY89 cohort have promotion times about 12 percent slower than those in the FY83 cohort.

### Occupation

Promotion opportunities vary substantially by occupation. Promotion times in the medical/dental and craftsmen areas are about 20 percent slower than in combat specialties. Other specialties have a promotion tempo at least 10 percentage points slower than combat with the exception of those in the communications/intelligence area, which are not significantly different than combat.

The coefficients in the second equation follow the same general pattern as in the first, but the effects are slightly smaller. Soldiers in combat specialties move up in the queue faster than those in other

specialties, and the slowest moving areas are medical/dental and functional support/administration.

### Soldier Characteristics

The results show that soldier educational attainment has an important bearing on the promotion success. Soldiers with some post-secondary schooling have promotion times about 7 percent faster than high school graduates and, for a given promotion point ranking, move up about 4 percent faster in the promotion queue than do graduates. Soldiers with certificates of General Educational Development (GED) have expected promotion times comparable with those of high school graduates. Nongraduates, on the other hand, have promotion times about 16 percent slower than graduates, and nongrads move up nearly 10 percent slower in the promotion queue. In 1987, the Army changed its policy and restricted E5 promotions to soldiers with a high school diploma, a GED, or an associate or higher degree.

AFQT is inversely related to expected promotion time—soldiers with higher aptitudes get promoted faster than does the average soldier. The results suggest that a 10 percentage point increase in AFQT is associated with about a one-and-a-half month decrease in expected promotion time. The AFQT effect was diminished by the inclusion of promotion points (smarter soldiers acquire points more quickly). Among soldiers with comparable points, AFQT continues to provide an edge in acquiring more points and getting promoted more quickly.

### Promotion Status and Points

As one might expect, soldiers who are promoted more rapidly to E4 are also more likely to be promoted to E5. Surprisingly, though, the time trade-off is essentially one-for-one—a one-month increase in time to E4 implies a one-month increase in expected time to E5. Apparently, early E4 promotion provides little additional information about how quickly one will reach E5.

Soldiers who have not yet become promotion eligible for E5 by the end of the first term are way behind those already promoted or in the promotion queue. Table 4.1 shows that those not yet E4(P) have expected promotion times about 13 percent (seven months) longer than the average.

Position in the promotion queue and promotion history also play important roles in expected time to E5. Holding constant other factors, a two-unit increase in the standardized promotion score implies a six-

month decrease in expected time to E5. The results also show that soldiers who take longer to reach E4 and E4(P) status will also take longer to move up in the promotion queue. Among soldiers with equal promotion points, a three-month delay in promotion to E4 implies about a two-month delay in promotion to E5. E5 promotion time is much more sensitive to when the soldier becomes E4(P)—a three-month delay in E4(P) status is associated with a three-month delay in E5 promotion. The importance of these promotion history variables even after controlling for promotion points suggests that these variables are picking up motivational, performance, or skill factors not otherwise captured by observed soldier characteristics.

## STANDARD RETENTION APPROACH

The retention results for the Army are summarized in Table 4.2, with detailed regression specifications relegated to Appendix B. The results are based on a basic retention specification that uses the military/civilian pay ratio as a summary measure of the differences in military and civilian opportunities at the end of the first term. The partial effects of each variable are computed for both the basic model without promotion timing and the joint promotion and retention model that controls for expected promotion time. The effects are divided into two groups: unit changes are calculated for indicator variables that reflect the difference between the retention of each variable relative to the reference category, and elasticities are computed for continuous variables to describe the effect of a percentage change in the variable on a percentage change in the retention level.

### Promotion Timing and Retention

The results show that promotion tempo has an important influence on retention decisions. The estimated elasticity of first-term retention with respect to expected E5 promotion time is –1.3. Other things equal, a 10 percent slowdown in expected promotion time (5.4 weeks) is associated with a 13 percent decline in the retention rate (5 percentage points). The promotion slowdown of the past few years has reduced the retention rate below what would have been expected if promotion tempo had continued at historical levels.

The omission of promotion tempo in the basic specification also means that the coefficients on other variables are biased. The basic specification can be considered a reduced-form specification that shows the

**Table 4.2**

**First-Term Retention Results for the Army**

| Variable | Basic Model | Adds Promotion Time |
|---|---|---|
| *Unit changes:* | | |
| Cohort group: | | |
| FY84 | –0.020 | –0.012 |
| FY85 | 0.031 | 0.063* |
| FY86 | 0.081* | 0.121* |
| FY87 | 0.084* | 0.115* |
| FY88 | 0.171* | 0.191* |
| FY89 | 0.240* | 0.310* |
| Occupational group: | | |
| Electronic equipment | 0.023 | 0.106* |
| Communications/intelligence | 0.054* | 0.054* |
| Medical/dental specialists | 0.090* | 0.211* |
| Other technical/allied specialists | 0.053 | 0.125* |
| Functional support/administration | 0.160* | 0.258* |
| Electrical/mechanical | 0.058* | 0.132* |
| Craftsmen | –0.034 | 0.081* |
| Service/supply handlers | 0.186* | 0.261* |
| GED certificate | 0.189* | 0.167* |
| Non-high-school graduate | –0.264* | –0.112* |
| Some post-secondary school | 0.048 | –0.027 |
| Black | 0.028 | 0.095* |
| Hispanic | –0.026 | –0.017 |
| Married | 0.130* | 0.108* |
| SRB[a] zero | 0.072* | 0.062* |
| *Elasticities:* | | |
| Number of dependents | 0.267* | 0.232* |
| AFQT score | –0.092* | –0.309* |
| SRB multiplier | 0.036* | 0.049* |
| Age at accession | 1.717* | 1.126* |
| Military/civilian pay | 1.598* | 1.051* |
| Unemployment at accession | –0.054 | –0.062 |
| Unemployment at retention | 0.147* | 0.141* |
| Expected E5 promotion time | — | –1.325* |
| Correlation (ρ) | — | –0.088* |

NOTE: Entries with asterisks are significant at the $\alpha = 0.05$ confidence level.

[a]Selective reenlistment bonus.

effect of a given variable on promotion tempo and retention *combined*.[1] Under this interpretation, the direct effect of a variable on

[1]For comparison purposes, the basic model is specified in the same form as in other studies. An alternative specification of the reduced-form equation would directly in-

retention could not be sorted out without some *assumption* of both how the variable affected promotion tempo and how promotion tempo affected retention. The joint promotion and retention model sorts out and estimates these separate effects.[2]

The joint promotion and retention model estimates an error term correlation between the promotion and retention equations. The hypothesis is that unobserved factors that are likely to delay promotion beyond that predicted in the promotion equation are likely to reduce the likelihood that a soldier will reenlist. For example, a soldier may have unusually strong civilian opportunities, so he may be uninterested in staying in the Army and reduce his efforts toward achieving E5 promotion. The results are consistent with this hypothesis and show a correlation of –0.088 between the error terms in the promotion and retention equations.

### Economic Conditions and Pay

The main policy variable estimated in retention models is the pay elasticity. The estimated pay elasticity without controlling for promotion tempo is 1.6, compared with 1.1 in the more general model. The basic model predicts that a 10 percent increase in military wage is associated with a 16 percent (7 percentage point) increase in retention, but the "true" pay effect (holding constant promotion timing) is an 11 percent (5 percentage point) increase in retention. The misspecified retention model overstates the pay elasticity by about 34 percent.

The results from the joint model can be used to monetize the cost of a delay in promotion tempo. Other things equal, the retention effects of a 10 percent increase in expected time to E5 (5.4 months delay) can be offset by a 12.6 percent increase in military pay. An E5 promotion is associated with about a 10 percent pay increase, so the monetized costs of the delay are roughly equivalent to the present value of forgoing the promotion for four months.

Another important policy variable is the selective reenlistment bonus (SRB) variable. The SRB elasticity means that a 10 percent increase in the average SRB multiple is associated with a 0.49 percent in-

clude the variables for time to E4, time to E4(P), a dummy indicating that the soldier has not yet reached E4(P), and promotion points. This alternative reduced form would correct for the omitted promotion information, but it would not provide structural estimates of the underlying supply parameters.

[2]The details of parameter biases are discussed in Appendix A.

crease in the retention rate. A one-unit increase in the SRB multiplier is associated with a 2 percentage point increase in retention.

Two unemployment variables were used to control available economic opportunities: home state unemployment rates at the soldier's accession and retention dates. Following Warner and Solon (1991), we expected that soldiers who entered under pressure from high civilian unemployment rates might be less likely to reenlist. The accession-month unemployment coefficient has the predicted sign but is not significantly different from zero. The retention-month unemployment rate does have a significant effect on retention: a 10 percent (0.7 percentage point) increase in unemployment is associated with a retention rate change from say 42 to 48 percent.

### Soldier Characteristics

The results indicate that some types of soldiers are more likely to reenlist than others even after controlling for differences in military and civilian opportunities. The individual differences may reflect either different tastes for the Army or that the military/civilian pay variable imprecisely adjusts for the real opportunities available to a particular group.

Reenlistment rates vary substantially with education level. Soldiers with GED certificates have reenlistment rates about 21 percentage points higher than their counterparts with high school diplomas.[3] Nongraduates have retention rates about 17 percentage points lower than graduates. The lower retention rates for nongraduates probably reflect increasing demand restrictions on reenlistment from this group during our observation period.

The coefficients associated with post-secondary education are insignificantly different from zero in both equations, but the coefficients differ significantly from one another. The omission of promotion in the first specification substantially biases the coefficient on the post-secondary education, because these soldiers have substantially better promotion prospects than do high school diploma graduates. The

[3]Attrition studies (Buddin, 1988) have shown that nongraduates and soldiers with GED certificates have attrition rates during the first term that are about twice those of high school diploma graduates. One reason for the significant GED coefficient is that the civilian opportunities for these soldiers may be overstated. The CPS reports years of education and does not distinguish high school diploma graduates from nongraduates who earn a GED. On this basis, comparable civilian earnings are assigned to both groups, but this average may overstate the opportunities available to those with GED certificates.

positive coefficient in the first specification reflects both these better promotion opportunities and a retention supply effect. After controlling for promotion opportunities, soldiers with post-secondary schooling are slightly less likely than graduates to reenlist.

The results show that the omission of promotion in the basic model substantially biases the coefficient on AFQT. The estimated elasticity of retention with respect to AFQT rises from –0.09 to –0.31 after adjusting for differences in promotion opportunities. The "true" effect of a 15 percentage point difference in AFQT is a 4 percentage point difference in retention and not the 1 percentage point difference predicted from the standard model.

Other individual characteristics are similar in both model specifications. Blacks have reenlistment rates about 9 percentage points higher than whites, but Hispanic reenlistment rates do not differ significantly from those of whites.[4] Married soldiers and soldiers with dependents are more likely to reenlist than are single soldiers. Married soldiers have retention rates about 11 percentage points higher than single soldiers, and each additional dependent is associated with a 5 percentage point increase in retention. Finally, the results indicate that retention rates are directly related to soldier age: each year increase in soldier age is associated with a 2 percentage point increase in retention.

### Occupational Differences

The retention rates differ substantially across occupation groups, and the occupation effects are very sensitive to the inclusion of promotion timing in the retention specification. As with other variables, the coefficients in the basic model reflect both retention and promotion effects, but the coefficients differ from those in the joint model because promotion rates differ substantially by occupational group. The coefficients in the joint model are an indication of what the retention rates *would have been* if promotion opportunities did not differ across occupational groups.

The results show that all areas have retention rates significantly higher than the infantry/combat arms specialty area. Predicted retention rates are more than 20 percentage points higher in the medi-

[4]The simple average retention rates for blacks and whites are 58 and 37 percent, respectively. The much smaller regression estimate reflects other controls in the regression model. Some retention studies have relied on aggregate data and have not been able to adjust for differences in black and white civilian opportunities.

cal/dental, functional support/administration, and service/supply handler areas than in infantry. At the lower end of the spectrum, communications/intelligence and craftsmen areas have retention rates only 5 and 8 percentage points higher than in the infantry, respectively.

The sharp inherent differences in retention across specialties suggest that some special, area-specific compensation policies are needed to achieve adequate manning in all areas. Promotion timing and SRBs are used to encourage retention in hard-to-fill occupations.

### Cohort Differences

The cohort results show that retention levels have increased substantially in recent years. The cohort effects in the basic specification are biased downward—retention rates were strong even in the face of slowed promotion tempo. The cohort pattern becomes much stronger after controlling for promotion timing. The results from the joint model indicate that the underlying retention rate increased from the base-year level (FY83) by 12 percentage points in FY87, by 19 percentage points in FY88, and by 31 percentage points in FY89.

The cohort variables measure differences in taste for the Army among retention cohorts, but they also reflect various demand constraints that may have been in effect in each respective year. The anomalous retention rates may be those of FY83 and FY84 instead of those in FY88 and FY89. The FY79 and FY80 accession cohorts contained large numbers of low-quality soldiers,[5] and Army policies may have restricted reenlistment eligibility for many of these low-quality soldiers as they reached their first-term reenlistment points in FY83 and FY84. This "weeding-out" of low-quality soldiers may have temporarily depressed the retention rates.

The demand-side aspects of the cohort effects can be sorted out by restricting the sample to high-quality soldiers, who were not nearly as likely as low-quality soldiers to face reenlistment eligibility difficulties. A supplementary analysis of high-quality soldiers shows that retention rates do not differ significantly for the FY83 through FY87 cohorts, but that the retention rates in FY88 and FY89 were 9 and 20 percentage points higher, respectively, than those in the FY83 reten-

[5]Soldier quality was much lower than expected at accession because the AFQT was misnormed during this period. The misnorming problem meant that AFQT scores were much higher for many soldiers than they would have been if the test had been properly normed. The Army admitted a large number of soldiers who would not otherwise have been allowed to enlist.

tion cohort after controlling for other factors in the joint model. These results suggest that demand restrictions probably held down retention rates in the earlier cohorts but that recent retention rates are still surprisingly strong.

## ACOL RETENTION APPROACH

We next examine whether the information on promotion timing significantly alters an ACOL retention model specification. In principle, the standard ACOL model implicitly controls for changes in promotion opportunities, but ACOL is generally based on average promotion times at the retention point.[6] These average times are biased because they are based on the average of those survivors who choose to stay in the Army until promotion, and some first-termers probably separate *because* they anticipate that their time to E5 will be above average.

The ACOL results are summarized in Table 4.3, and the complete regression specifications are reported in Appendix B. Our ACOL analysis relies on the basic ACOL formulation of Mackin et al. (1989). The specifications correspond to those for the military/civilian pay model, where ACOL replaces the ratio of current military/civilian earnings. We report three regression specifications: (1) a standard ACOL model specification that uses average promotion rates in the computation of the ACOL variable, (2) a modified ACOL specification that adjusts for differences in individual promotion opportunities at the end of the first term using the joint model of promotion and retention, and (3) a reestimated joint model in which individual promotion opportunities are incorporated in the computation of the ACOL.[7] This latter specification shows whether promotion opportunities at the end of the first term have an effect on retention over and above their monetized value as entered through ACOL.

### Promotion Timing and Retention

The results show that the ACOL variable is not adequately controlling for expected promotion tempo. The "old ACOL" specification of Table 4.3 shows that the expected time to E5 has a substantial influ-

[6]Two prominent inventory projection models use a version of ACOL based on average promotion times (Mackin et al., 1989; Shukiar et al., unpublished manuscript). In fact, Shukiar et al. rely on the Mackin et al. ACOL specification.

[7]We did not estimate promotion models for promotions beyond E5. In the computation of ACOL, we assumed that individuals would maintain their same relative promotion position in subsequent promotions as for promotion to E5.

**Table 4.3**

**First-Term ACOL Retention Results for the Army**

| Variable | ACOL Model | Adds Promotion Time | |
|---|---|---|---|
| | | Old ACOL | New ACOL |
| *Unit changes:* | | | |
| Cohort group: | | | |
| FY84 | 0.000 | 0.004 | 0.002 |
| FY85 | 0.052* | 0.082* | 0.082* |
| FY86 | 0.106* | 0.143* | 0.143* |
| FY87 | 0.125* | 0.146* | 0.147* |
| FY88 | 0.199* | 0.217* | 0.221* |
| FY89 | 0.243* | 0.328* | 0.328* |
| Occupational group: | | | |
| Electronic equipment | –0.002 | 0.096* | 0.096* |
| Communications/intelligence | 0.053* | 0.059* | 0.059* |
| Medical/dental specialists | 0.060* | 0.201* | 0.204* |
| Other technical/allied specialists | 0.041 | 0.129* | 0.131* |
| Functional support/administration | 0.148* | 0.265* | 0.269* |
| Electrical/mechanical | 0.030* | 0.118* | 0.120* |
| Craftsmen | –0.064* | –0.069* | 0.071* |
| Service/supply handlers | 0.165* | 0.262* | 0.266* |
| GED certificate | –0.209* | –0.141* | –0.124* |
| Non-high-school graduate | –0.306* | –0.177* | –0.157* |
| Some post-secondary school | 0.007 | –0.055 | –0.056 |
| Black | 0.078* | 0.111* | 0.128* |
| Hispanic | 0.053 | 0.032 | 0.032 |
| Married | 0.123* | 0.103* | 0.104* |
| *Elasticities:* | | | |
| Number of dependents | 0.272* | 0.234* | 0.237* |
| AFQT score | –0.046 | –0.296* | –0.296* |
| Age at accession | 0.794* | 0.618* | 0.608* |
| ACOL (military pay) | 1.801* | 1.461* | 1.141* |
| Unemployment at accession | –0.061 | –0.069 | –0.069 |
| Unemployment at retention | 0.149* | 0.145* | 0.146* |
| Expected E5 promotion time | — | –1.429* | –1.323* |
| Correlation (ρ) | — | –0.135* | –0.137* |

NOTE: Entries with asterisks are significant at the $\alpha = 0.05$ confidence level.

ence on retention *over and above* the ACOL adjustments for average promotion time within each cohort. The elasticity of retention with respect to expected promotion time is –1.4, virtually the same level estimated in the earlier pay ratio analysis. The results imply that a 10 percent promotion slowdown (5.4 weeks) is associated with a 14 percent reduction in retention (6 percentage points).

Expected promotion time also has an important effect on retention after the effects of promotion timing have been incorporated into the

ACOL computation. The "new ACOL" specification shows that the elasticity of retention with respect to expected E5 promotion time is –1.3, after the effects of differences in E5 promotion timing have been monetized in the computation of ACOL. The significance of promotion time in this third specification suggests that promotions are associated with substantial nonpecuniary benefits over and above the monetary value of the promotion itself. We cannot, of course, dismiss the possibility that promotion time is significant because the ACOL formulation does not adequately monetize the value of the promotion. Nonetheless, the model results indicate substantial promotion effects that are not adequately accounted for by the standard ACOL formulation or even by an enhanced ACOL formulation that accounts for individual variation in promotion opportunities.

The error term correlation between the promotion and retention equations is –0.14 in both joint models, only slightly higher than in the pay ratio model of the subsection above. The significant correlation for the error term is an indication that unobserved factors that influence promotion also influence retention decisions.

As with the pay ratio model, the significance of the correlation and the coefficient on expected promotion timing means that the coefficients in the basic model are biased. Both versions of the joint promotion and retention model fit better than the standard ACOL specification: the $\chi^2$ associated with adding promotion timing to the standard ACOL specification is 1194.38 and the 1 percent critical value of $\chi^2$ for two degrees of freedom is 9.21. The overall likelihood for the "new ACOL" version of the model is slightly less than for the "old ACOL" version, but the $\chi^2$ associated with comparing the "new ACOL" and standard ACOL without promotion timing is 1183.53.

For the most part, the estimated retention effects in the ACOL specification mirror those in the pay ratio specification. The parameter biases in the models without promotion timing are also similar, because the estimated correlation and promotion timing effects are about the same. Also, the "old ACOL" and "new ACOL" specification yield similar parameter estimates for most variables other than ACOL itself. For brevity, our discussion will concentrate on the parameters of the joint promotion and retention specification that monetizes the effect of promotion timing.

### Economic Conditions and Pay

In the ACOL model, the estimated pay elasticity is not a simple function of the ACOL coefficient. Rather, the elasticity of retention with

respect to military pay is equal to the product of the elasticity of retention with respect to ACOL and the elasticity of ACOL with respect to pay. For convenience, the reported ACOL elasticity in Table 4.3 is the military pay elasticity. The estimated pay elasticity in the ACOL specification falls from 1.8 without promotion timing to 1.5 with promotion timing in the "old ACOL" specification and to 1.1 in the "new ACOL" specification. Our best estimate of the ACOL elasticity is the elasticity of 1.1 from the model that monetizes the value of differences in individual promotion status at the end of the first term. The pay elasticity suggests that a 10 percent increase in military pay would result in an 11 percent (5 percentage point) increase in retention. The bias in the estimated pay elasticity is slightly larger in the ACOL specification than in the pay ratio specification, but the pay elasticities in the joint model are very similar.

The unemployment effects are the same as those in the pay ratio model. Accession-month unemployment does not significantly affect retention, but a 10 percent increase (0.7 percentage point) in retention month unemployment is associated with a 15 percent increase (6 percentage point) in retention.

### Soldier Characteristics

The results show that the estimated AFQT elasticity in the standard ACOL specification is biased and substantially understates the underlying elasticity between retention and AFQT. The estimated AFQT elasticity rises (in absolute terms) from –0.05 without controlling for promotion timing to –0.30 after adjusting for promotion. The standard ACOL model predicts that a 15 percentage point increase in AFQT is associated with an 0.5 percentage point decrease in retention, but the joint model predicts a 3.5 percentage point decrease in retention. The AFQT effect is particularly biased in the absence of promotion timing, because AFQT has an important bearing on promotion timing.

The coefficient on post-secondary schooling also changes substantially after controlling for promotion opportunities. These well-educated soldiers have expected E5 promotion times about 6 percent shorter than do high school diploma graduates. Since soldiers are quite responsive to promotion times, the standard ACOL specification substantially biases coefficients associated with factors that affect both promotion and retention. The standard ACOL model suggests a small positive coefficient for post-secondary schooling. After adjusting for differences in promotion opportunities, soldiers with some post-sec-

ondary education have retention rates about 6 percent lower than do high school diploma graduates.

The GED coefficients in the ACOL specification suggest that these soldiers are much less likely to reenlist than are high school diploma graduates. This effect may differ from that in the pay ratio model for a technical reason that cannot be unambiguously resolved. In the military/civilian pay ratio, civilian earnings were defined on the basis of *years of schooling*, because the CPS does not separately identify earnings by diploma/GED status. Soldiers with GED degrees were assigned 12 years of schooling and awarded the corresponding CPS earnings, because we believed that many GED respondents to the CPS reported their years of schooling in this way. In the ACOL model, on the other hand, the civilian earnings of GED soldiers are lumped with those of nongraduates. Unfortunately, existing databases do not provide evidence on the earnings of individuals with GEDs relative to nongraduates and graduates.

The seemingly conflicting effects of GED in the two specifications are reasonable, given the difference in assignment of civilian earnings. The effects from the pay ratio model indicate that GEDs are much *more* likely than graduates to reenlist when their civilian earnings are assumed to be equivalent to those of graduates. The ACOL results indicate that GEDs are much *less* likely than graduates to reenlist when their civilian earnings profiles are assumed to be equivalent to those of nongraduates. An appropriate inference is that GEDs have civilian earnings between those of nongraduates and graduates. Any "taste" effect associated with GED status cannot be identified without a better understanding of their appropriate civilian opportunities.

The retention effects for black and accession age also differ substantially between the ACOL and pay ratio specifications. As with GED status, these variables are used in the imputation of ACOL and the military/civilian pay ratio. The ACOL results suggest that black retention rates are 13 percentage points higher than those of whites after adjusting for differences in ACOL and promotion timing. A one-year increase in soldier age at accession is associated with a one percentage point reduction in retention.

The other soldier characteristics have similar effects in the ACOL and pay ratio specifications. The ACOL results show that the retention rates of nongraduates are 16 percentage points lower than those of comparable high school graduates. The retention rates of Hispanics do not differ significantly from those of non-Hispanics. Married soldiers have retention rates 10 percentage points higher than single

soldiers. Each increase in the number of soldier dependents is associated with a 6 percentage point increase in the predicted retention rate.

### Occupational and Cohort Differences

The estimated occupational and cohort differences in retention are quite similar in the ACOL and pay ratio specifications. The coefficients on the cohort variables indicate that retention rates have been unusually high in recent cohorts, given changes in other factors such as the quality composition of the force and military compensation. The cohort effects estimated from the basic ACOL model specification are biased downward because they do not account for the promotion slowdown of recent years.

The standard ACOL model implicitly embeds differences in promotion timing by occupation in the estimated occupational effect on retention. The joint model separates these effects and shows that inherent retention differences by occupational areas are large after controlling for differences in the timing of promotion in these areas.

# 5. ANALYSIS OF ARMY OCCUPATIONAL AREAS

This section examines differences in Army promotion timing and retention within three key occupational areas: infantry (combat arms), communications/intelligence, and electrical/mechanical equipment repair. Personnel in these three areas constitute about 75 percent of the cohorts making first-term retention decisions. The results show that parameters of the model vary significantly across occupational areas: a $\chi^2$ of 640 is computed for the likelihood ratio test comparing the joint retention and promotion model, in which parameters are constrained to be constant across occupational areas (with separate intercepts for each area), with a model in which the parameters are allowed to vary by the three occupational areas and another composite area. The 1 percent critical value for the $\chi^2$ with 139 degrees of freedom is 181. The significant difference in parameters across occupations indicates that the overall summary estimates that are reported in most retention studies may be misleading for many policy purposes.

Promotion opportunities vary considerably by occupational area, so it is possible that the opportunities available to particular groups of soldiers might differ across occupations.[1] For example, a high AFQT score might contribute more to E5 promotion in an area that requires academic proficiency. In addition, Army promotions are driven by demand (vacancies), and Army authorizations in occupations may not be distributed proportionately by paygrade, so it is likely that the promotion slowdown has differentially affected some areas more than others.

Retention factors may also differ by occupational area. Civilian opportunities are likely to vary considerably with military occupation, since some military skills have close civilian counterparts and others do not. The retention models do not fully account for these differences, so it is likely the average overall pay elasticities are overstated for some occupations and understated for others.[2] Promotion timing

[1]Our estimates are conditional on the rules and procedures that the Army uses to assign soldiers to specialties. In general, the eligibility criterion for specialties did not change dramatically between FY83 and FY89.

[2]Neither our military/civilian pay or ACOL variable adjusts for differences in soldier opportunities by occupation. Smith et al. (1991) constructed an ACOL variable that allowed for differences in civilian opportunities by active-duty occupation. These earning differentials were based on the civilian earnings of military separatees.

may have a differential effect on retention in different areas through its effect on effective military/civilian pay. In addition, E5 promotion may be more attractive in some occupations than in others, because the higher rank may afford more interesting and challenging responsibilities in certain areas.

This section concentrates on interoccupational comparisons of the pay ratio specification of the joint promotion and retention model. The ACOL specifications were not sufficiently different from those of the pay ratio specification to warrant separate reporting. Promotion timing is important in each specification, so the retention specifications without timing are not reported by occupational area. The particular coefficient biases are similar to those reported in Section 4.

## PROMOTION RESULTS FOR ARMY OCCUPATIONAL AREAS

Table 5.1 describes how promotion timing varies by occupational area: average expected time to E5 is similar in the infantry and communications/intelligence areas at about 47.5 months, as compared with 59.5 in the electrical/mechanical repair area.[3] Only 29 percent of the soldiers in the electrical/mechanical repair area are high quality, but 59 and 70 percent of the infantry and communication/intelligence area soldiers are in the high-quality group.

### Cohort

The cohort variables show that soldier movement in the promotion queue has varied considerably over time in the occupational areas. Promotion tempo is decreasing in some areas and increasing in others, although the tempo in the most recent cohorts is consistently slow by historical standards. In the infantry and communications/intelligence areas, promotion tempo increased (average time to E5 decreased) in FY84 relative to FY83 before beginning a steady decline. The promotion tempo in FY89 was 15 and 21 percentage points slower in the infantry and communications/intelligence areas, respectively, than in FY84. In the electrical/mechanical area, promotion tempo declined earlier (FY85 and FY86) than in the other two areas, and promotion tempo in FY89 was 19 percent slower than in FY83.

Unfortunately, the data were based on individuals who separated from 1972 through 1980. We believe that changes in both the civilian economy and military personnel over the last decade made the predictions from these models inappropriate for our analysis.

[3]Detailed promotion and retention specifications are provided in Appendix B.

**Table 5.1**

**Expected E5 Promotion Time Regressions for Army Occupational Areas**

| Variable | Infantry | Communications/ Intelligence | Electrical/ Mechanical |
|---|---|---|---|
| Intercept | 2.9741* | 2.9378* | 3.2016* |
| Cohort group: | | | |
| FY84 | –0.0513* | –0.0924* | 0.0252 |
| FY85 | –0.0104 | –0.0617 | 0.0810* |
| FY86 | 0.0679* | 0.0403 | 0.0912* |
| FY87 | 0.0386 | 0.0927* | 0.0054 |
| FY88 | 0.0891* | 0.1362* | 0.0854* |
| FY89 | 0.1049* | 0.1248* | 0.1891* |
| Occupational group: | | | |
| Job 1 | –0.0161 | 0.0534* | 0.0527* |
| Job 2 | 0.0124 | 0.0192 | –0.0399 |
| Job 3 | 0.0646* | –0.0620* | 0.0777* |
| Job 4 | –0.0929* | 0.1974* | |
| GED certificate | –0.1208* | –0.0541 | 0.0372 |
| Non-high-school graduate | 0.0512 | 0.1171 | 0.0669* |
| Some post-secondary | –0.0126 | –0.0430 | 0.0201 |
| AFQT score | –0.0014* | –0.0020* | –0.0018* |
| Time to E4 | 0.0118* | 0.0107* | 0.0043* |
| Time to E4(P) | 0.0171* | 0.0204* | 0.0164* |
| Not yet E4(P) | 0.0997* | 0.0941* | 0.1768* |
| Promotion point score | –0.0379* | –0.0274* | –0.0626* |
| Expected E5 promotion time | 48.715 | 48.486 | 59.494 |

NOTES: The omitted reference group is high school graduates in an infantry/combat specialty in the FY83 retention cohort. Promotion time is measured in natural logarithms. Entries with asterisks are significant at the $\alpha = 0.05$ confidence level.

"Jobs" are defined separately in each area. In the infantry, the job groups are general infantry, armor, and combat engineering, respectively, with a reference group of artillery. In the communications/intelligence area, jobs are the occupational subgroups radio code, signal intercept, combat operations control, and signal analysis, respectively, with a reference group of all other skills. In the electrical/mechanical repair area, the job groups are general automotive, track vehicle, construction, and wire communications linemen, with a reference group of other skills.

## Occupation

Within each area, we identified several key occupations that constitute a large share of the jobs in the occupational area. The results indicate whether promotion tempo is relatively fast or slow in these dominant jobs. In the infantry, the results show that the promotion tempo is comparable for general infantry, armor, and artillery jobs,

but that E5 promotion takes about 6 percent longer in combat engineering than for the other jobs in the area. Within the communications/intelligence areas, tempo varies substantially by occupation. Radio-code specialties have E5 promotion times 5 percent faster than the other specialties group, whereas combat operations control and signal analysts have promotion times 6 and 9 percent slower than the other group. In the electrical/mechanical repair area, general automotive, construction, and wire communications linemen have promotion tempos 5, 8, and 20 percent slower than that for other specialties in the occupational area.

### Soldier Characteristics

After adjusting for promotion points, the expected time to E5 does not differ much by the level of educational attainment. Soldiers with post-secondary training do not move up more quickly than high school diploma graduates in any of the occupational areas. Non-high-school graduates have slower promotion tempos in each area, but the effect is only statistically significant in the electrical/mechanical repair area. We saw above that soldiers with GEDs had overall promotion tempos comparable to those of high school diploma graduates. Surprisingly, the results in Table 5.1 indicate that in the infantry area GED soldiers have expected E5 promotion times 12 percent shorter than those of high school diploma graduates.

AFQT score has a comparable effect on promotion tempo in the three occupational areas. AFQT, like education, has an important effect on promotion points, and even after controlling for points, those with higher AFQT scores have shorter promotion times than those with lower scores. The AFQT effect in moving up the promotion ladder is quite consistent across occupational areas.

### Promotion Status and Points

The results in Table 5.1 reiterate the importance of controlling for promotion eligibility and points in predicting time to E5. In each area, time to E4, time to E4(P), E4 eligibility, and promotion score all have significant effect on E5 promotion tempo.

In each area, soldiers who have not yet reached E4(P) by the end of their first term have poor promotion prospects. In the infantry and communications/intelligence areas, these soldiers have promotion times about 10 percent slower than the average. In the electrical/mechanical area, those not yet in the E5 promotion pool have promotion times about 18 percent (11 weeks) slower than the average.

For the most part, time to E4 and time to E4(P) have comparable effects across areas: those who reached E4 or E4(P) relatively quickly are more likely to move up quickly. The implication is that factors that make soldiers more likely to reach E4 or E4(P) (i.e., skill, motivation, or taste for Army life) will have a continuing influence on his ability to reach E5. Other things equal, a soldier who reaches E4 three months ahead of schedule can expect to reach E5 about two months faster than average. Among soldiers with common points and history, those who reached E4(P) three months early will reach E5 about three months faster than the average.

The results indicate that, for a given position in the promotion queue, soldiers in the electrical/mechanical repair area can expect to move up much more quickly than those in the communications/intelligence area. For example, consider soldiers with promotion scores one standard deviation above average in each area. These "fast-movers" have expected E5 promotion times 1.8, 1.3, and 3.7 months shorter in the infantry, communications/intelligence, and electrical/mechanical repair areas, respectively, than a soldier with an average score. Soldiers who have reached E4(P) have much more variance in their expected E5 promotion time in the electrical/mechanical repair area than in the other two occupational areas.

## RETENTION RESULTS FOR ARMY OCCUPATIONAL AREAS

### Promotion Timing and Retention

Table 5.2 shows that expected E5 promotion time has an important effect on retention in each occupational area. The elasticity of retention with respect to promotion tempo ranges from –1.7 in electrical/mechanical repair to –1.1 in communications/intelligence. Other things equal, a six-month delay in promotion tempo is associated with about a 6 percentage point reduction in retention in the infantry or communications/intelligence areas but with a 8 percentage point reduction in retention in the electrical/mechanical repair area.

### Economic Conditions and Pay

The unemployment and pay variables have similar qualitative effects in all three areas, but the size of the effects varies considerably. The wage elasticity varies from 1.4 for infantry to 0.9 for the electrical/mechanical repair area. The lower elasticity for electrical/mechanical repair jobs reflects the fact that these skills transfer more directly to civilian sector jobs than do those in the other areas. Many soldiers

**Table 5.2**

**First-Term Retention Results for Army Occupational Areas**

| Variable | Infantry | Communications/ Intelligence | Electrical/ Mechanical |
|---|---|---|---|
| *Unit changes:* | | | |
| Cohort group: | | | |
| FY84 | –0.045 | –0.065 | 0.074 |
| FY85 | 0.004 | –0.011 | 0.144* |
| FY86 | 0.078 | 0.046 | 0.191* |
| FY87 | 0.089 | 0.065 | 0.133* |
| FY88 | 0.152* | 0.167* | 0.227* |
| FY89 | 0.236* | 0.176* | 0.390* |
| Occupational group: | | | |
| Job 1 | 0.008 | 0.031 | 0.020 |
| Job 2 | 0.110* | –0.109* | –0.074 |
| Job 3 | 0.098* | –0.147* | 0.019 |
| Job 4 | | –0.074 | 0.080 |
| GED certificate | 0.216 | 0.060 | 0.174* |
| Non-high-school graduate | –0.109 | –0.183 | –0.083 |
| Some post-secondary | –0.005 | 0.000 | 0.048 |
| Black | 0.031* | 0.012 | 0.081* |
| Hispanic | –0.000 | 0.001 | –0.005 |
| Married | 0.118* | 0.131* | 0.080* |
| *Elasticities:* | | | |
| Number of dependents | 0.295* | 0.252* | 0.240* |
| AFQT score | 0.175* | 0.111* | 0.039* |
| SRB multiplier | –0.237* | –0.376* | –0.287* |
| Age at accession | 1.451* | 1.629* | 0.765* |
| Military/civilian pay | 1.400* | 1.339* | 0.868* |
| Unemployment at accession | –0.012 | –0.028 | –0.210* |
| Unemployment at retention | 0.189* | 0.096 | 0.219* |
| Expected E5 promotion time | –1.138* | –1.056* | –1.746* |
| Correlation (ρ) | –0.013* | –0.029* | –0.241* |
| Retention rate | 0.395 | 0.452 | 0.429 |

NOTES: "Jobs" are defined separately in each area. In the infantry, the job groups are general infantry, armor, and combat engineering, respectively, with a reference group of artillery. Jobs refer to the occupational subgroups radio code, signal intercept, combat operations control, and signal analysis, respectively, in the communications/intelligence area, with a reference group of all other skills. In the electrical/mechanical repair area, the job groups are general automotive, track vehicle, construction, and wire communications linemen, with a reference group of other skills.

may have entered the Army for this on-the-job training, so their subsequent stay/leave decision is less sensitive to military pay than it is in the infantry area where skills are not transferable.

Like military pay, the SRB effects on retention are higher in the infantry than in communications/intelligence and electrical/mechanical

repair. A one-point increase in the bonus multiple is associated with a 7, 5, and 5 percentage point increase in retention in the infantry, communications/intelligence, and electrical/mechanical repair areas, respectively.

In each area, higher accession-month unemployment is associated with lower retention, but only in the electrical/mechanical repair area is the effect significant. The results suggest that, for soldiers in this area, a 10 percent increase (0.8 percentage point) in accession-month unemployment is associated with a 2.2 percent (0.9 percentage point) decrease in retention. Soldiers that are drawn into the electrical/mechanical repair area during hard economic conditions are disproportionately likely to leave at the end of their first term and take advantage of their military training in the civilian sector.

Higher retention-month unemployment means that fewer civilian opportunities are available and that the retention rate should increase. The results show that a 10 percent increase (0.8 percentage point) in retention-month unemployment is associated with about a 2 percent increase (1 percentage point) in the retention rate in the infantry and electrical/mechanical repair area. Retention-month unemployment has no significant effect on retention in the communications/intelligence area.

### Soldier Characteristics

Educational background has a similar effect on retention in all three areas. Soldiers with GEDs have retention rates higher than those of high school diploma graduates, but the effect is significant only in the electrical/mechanical area. Nongraduates have much lower retention rates than do diploma graduates, and this result probably reflects demand restrictions on reenlistment and promotion opportunities for nongraduates. Soldiers with some post-secondary training do not have retention rates significantly different from those of high school diploma graduates.

Marital status and number of dependents also have similar retention effects in all three areas. Married soldiers have retention rates 8 to 13 percentage points higher than do single soldiers, depending on occupational area. Retention also rises sharply with the number of dependents in each area.

The results indicate that higher aptitude soldiers are less likely to reenlist in each area. As we saw in the last section, the AFQT effects *conditional* on expected promotion time are much larger than those traditional estimates that do not control for promotion. The AFQT ef-

fect is particularly large in the technical communications/intelligence area.[4] A 10 percent increase in the average AFQT score of a communications/intelligence retention cohort is associated with a 4 percent reduction in retention.

Retention rates are positively related to soldier age. The elasticity of retention with respect to age is about 1.6 in the communications/intelligence area, but falls to 0.8 in the electrical/mechanical repair area. The age effects are conditional on civilian opportunities that account for age differences in earnings, so this result suggests that either older soldiers have greater taste for the Army than do younger soldiers or that older soldiers who join the Army have relatively worse civilian opportunities than their civilian counterparts.

### Occupations

Other things equal, retention rates differ significantly among predominant jobs in two of the three areas. In infantry, armor, and combat engineering, jobs have retention rates 11 and 10 percentage points higher than those in the general infantry and artillery. In communications/intelligence, the retention rates are 11 and 15 percentage points lower in signal intercept and combat operations control jobs, respectively, than in other jobs. After controlling for other factors, retention did not vary significantly by occupation within the electrical/mechanical repair area.

### Cohorts

Table 5.2 shows that retention has been stronger in recent cohorts than would have been expected from other factors in the model. In particular, the cohort effects start earlier and are much larger in the electrical/mechanical repair area than in the other skill areas. In part, however, the FY83 and FY84 cohorts may have been more anomalous in the electrical/mechanical repair, because this area has a large share of low-quality soldiers and may have faced more demand restrictions during these years.

[4]Nearly 70 percent of the communications/intelligence area soldiers are high quality.

# 6. PROMOTION AND RETENTION RESULTS FOR THE AIR FORCE

Promotion times in the Air Force are much slower than in the Army, with average time in service at promotion to E5 ranging from 63 months in FY83 to 78 months in FY89. The slower promotion pace means that few airmen have reached E5 at the end of their first term and that most are well into their second term before reaching E5. Nonetheless, airmen have information on WAPS scores and promotion rates, so they are able to anticipate promotion timing.

The promotion and retention results are presented in the same format as those of the Army. This section describes the Air Force results for airmen as a whole, with controls for broad occupational differences in promotion and retention. Section 7 examines three large occupational areas to find if key model parameters differ across the occupational groups.

## PROMOTION TIMING

The results from the promotion portion of the promotion and retention model are presented in Table 6.1. The basic model without promotion points shows the unconditional effect of each factor on expected time to E5, whereas the second specification with promotion points indicates how quickly particular types of individuals move up in the promotion queue. In both cases, the models are adjusted for the fact that most individuals have not reached E5 and that many will leave the Air Force because their promotion prospects are below average. The average expected time to E5 is about 72 months.

The promotion points information available for the Air Force is slightly different from information for the Army. Some airmen are not yet eligible for promotion to E5 and do not have WAPS scores at the end of the first term. For those with scores, WAPS provides information on airman rank in the promotion queue, the size of the queue, and how many were promoted from the promotion queue. The promotion information is provided by Air Force Specialty Code (AFSC), but Air Force policy severely limits variance in promotion rates across AFSCs. The Air Force defines two basic promotion groups: one group includes all eligibles in which severe shortages would affect readiness—chronic critical shortage (CCS) AFSCs—and

**Table 6.1**

**Estimated Air Force Regression Coefficients for Expected Time to E5 (standard errors in parentheses)**

| Variable | Basic Model | | Adds Promotion Points | |
|---|---|---|---|---|
| Intercept | 3.7917* | (0.0206) | 3.7237* | (0.0218) |
| Cohort group: | | | | |
| FY84 | –0.0243* | (0.0095) | –0.0067 | (0.0089) |
| FY85 | –0.0103 | (0.0094) | 0.0167 | (0.0089) |
| FY86 | 0.0012 | (0.0098) | 0.0336* | (0.0092) |
| FY87 | –0.0056 | (0.0099) | 0.0102 | (0.0094) |
| FY88 | 0.0236* | (0.0110) | 0.0059 | (0.0108) |
| FY89 | 0.0762* | (0.0151) | 0.0504* | (0.0153) |
| Occupational group: | | | | |
| Electronic equipment | 0.0297* | (0.0117) | 0.0299* | (0.0111) |
| Communications/intelligence | 0.0006 | (0.0145) | 0.0111 | (0.0138) |
| Medical/dental | 0.0320* | (0.0158) | 0.0226 | (0.0149) |
| Other technical/allied | 0.0246 | (0.0161) | 0.0330* | (0.0152) |
| Functional support/administration | 0.0254* | (0.0112) | 0.0236* | (0.0105) |
| Electrical/mechanical | –0.0254* | (0.0106) | –0.0035 | (0.0100) |
| Craftsmen | 0.0023 | (0.0143) | 0.0121 | (0.0136) |
| Service/supply handlers | –0.0078 | (0.0124) | 0.0001 | (0.0118) |
| GED certificate | 0.0137 | (0.0144) | 0.0248 | (0.0135) |
| Non-high-school graduate | 0.0821 | (0.0453) | 0.0610 | (0.0423) |
| Some post-secondary school | –0.0121 | (0.0094) | –0.0135 | (0.0089) |
| AFQT score | –0.0031* | (0.0001) | –0.0022* | (0.0001) |
| Time to E4 | 0.0189* | (0.0004) | 0.0161* | (0.0004) |
| Not yet E4(P) | | | 0.0710* | (0.0113) |
| Relative promotion position (percent) | | | 0.0046* | (0.0001) |
| Percent selected for E5 | | | –0.0048* | (0.0005) |
| Log likelihood | –76.622 | | 547.97 | |

NOTES: The omitted reference group is high school graduates in an infantry/combat specialty in the FY83 retention cohort. Promotion time is measured in natural logarithms. Entries with asterisks are significant at the $\alpha = 0.05$ confidence level. E4(P) refers to E4 promotable, that is, promotion eligible for E5.

the second group includes eligibles in all other AFSCs. Within a promotion cycle, CCS skills are allowed to have promotion rates 5 percentage points higher than those in non-CCS skills.

The results show that the added promotion point information substantially improved our ability to predict promotion tempo. The log likelihood improved substantially when the promotion point information was added to the basic model. This improvement implies that the promotion information is adding unique new information on sol-

dier quality over and above the traditional measures of entry characteristics such as AFQT score and education. With average promotion time two or three years down the road, it is perhaps surprising that position in the queue at the end of the first term is such a powerful predictor of ultimate promotion time.

Expected E5 promotion time varies considerably less for the Air Force than for the Army. In both services, a one-unit standard deviation in the expected promotion time is associated with about a 14-month change in promotion tempo, but the average tempo is 55 months in the Army and 72 months in the Air Force. The relative variance in Air Force opportunities is considerably less than in the Army. The low variance in the Air Force can be attributed to three factors. First, the Air Force promotion philosophy is to equalize promotion opportunities and to limit the use of promotion tempo to manage retention imbalances across skills. Second, the Air Force system is primarily seniority driven and our approach effectively holds seniority constant by looking at promotions within a given retention cohort. Finally, as a technical matter, expected E5 promotion time at the end of the first term might vary little because most airmen are several years away from promotion. It is possible, for example, that there would be more variance in expected promotion time if we looked at airmen with six years in service and were much closer (on average) to promotion.[1]

## Cohort

The results from the basic model show modest differences in promotion tempo by retention cohort. Expected time to E5 decreased by about 2 percent (two months) between FY83 and FY84. In FY85, promotion tempo reverted to about the FY83 level and remained virtually unchanged until FY88. Promotion tempo was 2 and 8 percent slower in FY88 and FY89 than in the FY83 base year. As compared with the Army, the changes in promotion opportunity are small, but comparable soldiers can expect to wait about six months longer for E5 promotion in the FY89 than in the FY83 retention cohort. Similarly, the second specification shows that there are small differences in the tendency of soldiers from any particular cohort to move up in the promotion queue.

[1]In the Army, soldiers were much closer to the average expected promotion time of 55 months at the end of their first terms.

### Occupation

The Air Force promises equal promotion opportunity across skills, and the results are certainly consistent with this philosophy. Expected promotion time varies little with occupational area. Airmen have promotion times about 3 percent slower than the average in the electronic equipment repair, medical/dental specialist, and functional support/administration areas. Promotion tempo in the electrical/mechanical repair area is about 3 percent faster than the average. The difference in promotion opportunity between the fastest and slowest area is only about four months. The results of the second specification with promotion points are quite similar to those of the first: given their promotion point information, airmen move up in the promotion queue at fairly comparable rates across occupational areas.

### Airmen Characteristics

Differences in airmen education levels have little bearing on expected promotion timing. As in the Army, soldiers with GEDs have a promotion tempo comparable with that of high school diploma graduates. The coefficient for nongraduates suggests that their promotion tempo is about 8 percent slower than for graduates, but very few airmen are nongraduates (0.3 percent), so the effect is measured imprecisely. About 7 percent of the airmen have some post-secondary schooling, but the results suggest that these better educated airmen have promotion rates comparable with those of airmen with only high school diplomas.

The results show that a 10 percentage point increase in AFQT score is associated with a two-month increase in promotion speed. When promotion point information is included, part of the AFQT effect is embedded in the WAPS score, but airmen with higher AFQT scores move up faster in the promotion queue. A 10 percent increase in AFQT is associated with a 1.3 percent reduction in expected E5 promotion time.

### Promotion Status and Points

The results show that E4 promotion time is positively related to expected E5 promotion time, but the magnitude of the effects is small. The same unmeasured characteristics (e.g., motivation or perseverance) that enable an airman to reach E4 ahead of the average will help him reach E5 ahead of the average airman. Overall, an airman who reaches E4 one month ahead of schedule is predicted to reach E5 1.4 months faster than the average airman. Similarly, after control-

ling for position in the promotion queue, an airman who reaches E4 a month early is predicted to reach E5 about 1.2 months early.

Airmen who have not yet reached eligibility for E5 at the end of the first term are substantially behind those who are in the WAPS promotion queue. Table 6.1 shows that those who are not yet E4(P) have promotion times about 7 percent slower than those with WAPS scores.

First-term airmen compete for promotion with soldiers in the career force, and their accumulated promotion points at the end of four years are generally well below the cut score for promotion. At the end of his first term, the average airman was in the top 45 percent of the eligible group, and the top 14 percent of the eligibles were selected for E5 promotion.[2] In recent promotion cycles, the percentage of eligible airmen who are promoted to E5 has varied considerably. The selection rate in FY83 was 15 percent, it rose to 20 percent in FY85, and it fell to 9 and 10 percent, respectively, in FY88 and FY89.

The results show that airmen who are closer to the promotion cut score at the end of the first term will ultimately reach E5 faster than the average soldier. Holding constant the percentage selected for promotion, an airman who is in the 30th percentile of the promotion queue will have an expected promotion time about three months shorter than the average airman in the 45th percentile.

As expected, the percentage selected for E5 is inversely correlated with expected promotion time. This result reflects several factors. First, a higher selection percentage increases the likelihood that an airman will be selected in the current cycle. Second, a higher selection percentage moves more airmen out of the promotion queue and creates more opportunity for the remaining eligibles to move up in future cycles. Third, selection percentages are higher in CCS skills, and these skills are likely to have persistently high selection percentages and shorter average promotion times. The results indicate that a four-point increase in the selection percentage is associated with a 1.4-month increase in average promotion time.

## STANDARD RETENTION APPROACH

Table 6.2 summarizes the Air Force retention results for a standard military/civilian pay ratio specification. The basic specification corre-

[2]Relative promotion position is measured from the top down, so that an airman in the 10th percentile scored in the top 10 percent of all eligible airmen in the promotion cycle.

**Table 6.2**

**First-Term Retention Results for the Air Force**

| Variable | Basic Model | Adds Promotion Time |
|---|---|---|
| *Unit changes:* | | |
| Cohort group: | | |
| FY84 | 0.043* | 0.049* |
| FY85 | –0.010 | 0.015 |
| FY86 | 0.044 | 0.070* |
| FY87 | 0.140* | 0.166* |
| FY88 | –0.016 | –0.002 |
| FY89 | 0.129* | 0.176* |
| Occupational group: | | |
| Electronic equipment | –0.054* | –0.015 |
| Communications/intelligence | 0.021 | 0.035 |
| Medical/dental | 0.007 | 0.037 |
| Other technical/allied | –0.012 | 0.016 |
| Functional support/ administration | 0.103* | 0.135* |
| Electrical/mechanical | 0.010 | 0.023 |
| Craftsmen | –0.025 | 0.001 |
| Service/supply handlers | 0.000 | 0.019 |
| GED certificate | 0.034 | 0.056* |
| Non-high-school graduate | –0.210* | –0.154 |
| Some post-secondary school | –0.033 | –0.092* |
| Black | 0.014* | 0.022* |
| Hispanic | –0.002 | –0.000 |
| Married | 0.161* | 0.153* |
| SRB multiple = 1 | 0.041* | 0.040* |
| *Elasticities:* | | |
| Number of dependents | 0.100* | 0.096* |
| AFQT score | –0.056 | –0.252* |
| SRB multiplier | 0.007 | 0.009 |
| Age at accession | 1.286* | 1.080* |
| Military/civilian pay | 1.154* | 1.021* |
| Unemployment at accession | –0.053 | –0.041 |
| Unemployment at retention | 0.157* | 0.136* |
| Expected E5 promotion time | — | –0.801* |
| Correlation (ρ) | | –0.288* |

NOTE: Entries with asterisks are significant at the $\alpha = 0.05$ confidence level.

sponds roughly with that of Carter et al. (1987). The second specification is based on the joint promotion and retention model and adds expected promotion time and allows for correlation between the error terms in the promotion and retention equations. The promotion information improves the fit of the retention equation: the $\chi^2$ statistic for including expected promotion time and error term correlation in

the retention equation is 285.0, where the critical value for $\chi^2$ with two degrees of freedom at the 1 percent level is 9.2. The detailed regression specifications are reported in Appendix C.

## PROMOTION TIMING AND RETENTION

As in the Army, the results show that promotion tempo has an important effect on retention. A 10 percent increase in expected promotion time (about seven months) is associated with an 8 percent reduction in retention (4 percentage points). The Air Force promotion elasticity of –0.80 is substantially less pronounced than that of the Army at –1.32, but the results show the importance of controlling for promotion tempo in predicting first-term retention.

The error term correlation for the Air Force is much larger than it is for the Army. The result suggests that there are substantial unmeasured taste factors that have opposite effects on promotion timing and retention. For example, unusually well-motivated airmen may have promotion times shorter than predicted from their observed characteristics, and the correlation implies that these airmen will have above average retention. In effect, many airmen may be thinking ahead and simultaneously deciding whether to concentrate on an E5 promotion and staying in the Air Force.

### Economic Conditions and Pay

The estimated military pay elasticity is 1.15 when promotion timing is excluded from the specification and falls to 1.02 when we adjust for differences in expected time to E5. The pay elasticity for the Air Force is quite similar to that of the Army (see Table 4.2): a 10 percent increase in military pay is associated with a 10.5 and an 11.5 percent increase in Army and Air Force retention, respectively. Air Force retention levels are higher than those of the Army (51 percent versus 42 percent), however, so that a 10 percent military pay hike would increase retention by about 4 and 6 percentage points in the Army and Air Force, respectively.

The results suggest that airmen are surprisingly sensitive to delays in E5 promotion, given that the average expected time to E5 is 72 months or two years from the first-term reenlistment point. A 10 percent or seven-month delay in promotion tempo means that an airman will defer a 10 percent pay hike for that period. The retention effects of such a 10 percent delay in expected time to E5 can be offset by an 8 percent increase in military pay. An 8 percent increase in

current pay would seem to be a steep price to defer a 10 percent pay increase from 24 months in the future to 31 months in the future.

The first bonus multiple is associated with a 4 percentage point increase in retention. This result is consistent with the 3.4 percentage point change reported by Carter et al. (1989). Increases in the bonus multiple beyond one are associated with small but insignificant increases in retention.

The unemployment effect on retention is quite similar to that in the Army. Unemployment at accession has the expected negative sign, but the effect is insignificant. As in the Army, a 10 percent (0.7 percentage point) increase in unemployment at retention is associated with a 1.4 percent decrease in retention rates.

### Soldier Characteristics

Black airmen have average retention rates of 69 percent as compared with 48 percent for white airmen, but most of this difference is accounted for by differences in civilian earnings opportunities. The retention results show that after controlling for civilian opportunities and other factors, blacks have retention rates about 2 percentage points higher than whites. Hispanics have average retention rates about 4 percentage points higher than non-Hispanics, but this difference disappears when other factors are controlled for in the multivariate model.

The results show that retention rates vary substantially by education level, even after controlling for the effects of education on promotion and earnings. Airmen with GED certificates have retention rates about 6 percentage points higher than those of high school diploma graduates. Nongraduates have retention rates 15 percentage points lower than graduates, probably reflecting demand restrictions on the ability to stay in the Air Force.

The effect of post-secondary schooling differs substantially between the two model specifications. When promotion timing is omitted, the schooling coefficient is biased and includes both the promotion and retention effects. Holding constant promotion timing, the results from the joint promotion and retention model show that airmen with post-secondary schooling have retention rates 9 percentage points lower than those of airmen with only high school diplomas. The better educated airmen stay at about the same rate as graduates, provided they also have a faster promotion rate than graduates. The standard model understates the effect of post-secondary schooling on retention by a factor of three.

As in the Army, the AFQT score elasticity is substantially biased by the omission of promotion tempo in the standard model. In the standard specification, AFQT score has no significant effect on retention rates. In the joint promotion and retention model, the elasticity of retention with respect to AFQT score is –0.25—a 15 percentage point increase in AFQT score is associated with a 3 percentage point reduction in retention. High-aptitude soldiers can earn a premium in military pay through faster promotion, but a promotion slowdown takes away a portion of the premium.

Married airmen and airmen with more dependents are more likely to reenlist than are single airmen. Married airmen have retention rates 15 percentage points higher than single airmen. Each successive increase in the number of dependents is associated with a 4 percentage point increase in retention. The effects of marriage and dependents are similar to those in the Army.

### Occupational Differences

After controlling for other factors, Air Force retention rates vary little by occupational area. In the basic model without promotion, the only areas with retention rates significantly different from those in the omitted combat category are electronic equipment repair (5 percentage points below combat) and functional support and administration (10 percentage points above combat). After adjusting for promotion tempo, the only significant difference is in functional support and administration, where the model results indicate that retention rates would be 13 percentage points higher than those in combat.[3]

### Cohort Differences

After controlling for other factors, retention rates varied substantially across retention cohorts. These cohort effects suggest either that Air Force demand conditions varied over the period or that airmen's taste for the Air Force has differed across year groups. In part, the cohort effects were dampened by changes in promotion tempo, so the "true" underlying effects are larger when promotion is added to the basic specification. The FY84, FY86, FY87, and FY89 cohorts had retention

[3]The infantry/combat occupational area as defined by the Department of Defense includes installation security; these security specialists in the Air Force constitute about 8 percent of all airmen in a retention cohort. Also, promotion times in functional support and administration were slower than those in other skill areas.

rates 5, 7, 17, and 18 percentage points higher than those for the FY83 base year.

## ACOL RETENTION APPROACH

We next report two tests of whether differences in individual promotion status at the end of the first term affect retention behavior. First, we determine whether a basic ACOL model for the first-term retention airman is sensitive to the inclusion of information on expected E5 promotion time. In principle, the ACOL model adjusts for promotion time by including changes in the *average* promotion rate. The joint promotion and retention specification shows whether additional information about *individual* promotion opportunities significantly affects retention.

In the second approach, ACOL is recomputed based on differences in expected time to E5 at the end of the first term. The joint promotion and retention model is then restimated with the "new ACOL" variable, and we will assess whether expected time to E5 has a significant effect on retention over and above the monetized effect of the promotion through the ACOL computation.

The retention results are summarized in Table 6.3, and the complete retention results are reported in Appendix C. The specifications are similar to those of the pay ratio model, in which the military/civilian pay ratio is replaced by the ACOL pay index.

### Promotion Timing and Retention

The results in Table 6.3 show that the ACOL adjustment for average promotion opportunities is an inadequate characterization of individual opportunities at the first-term retention point. In the "old ACOL" specification, expected E5 promotion time has significant explanatory power over and above the average promotion adjustment built into the ACOL variable. In fact, the promotion elasticity in the joint ACOL model is virtually identical with that in the earlier pay ratio version of the retention model. The elasticity estimate implies that holding constant other factors, including ACOL, a 10 percent increase in expected E5 promotion time is associated with a 9 percent reduction in retention; in other words, a seven-month delay in E5 promotion implies a 4 percentage point reduction in the retention rate.

**Table 6.3**

**First-Term ACOL Retention Results for the Air Force**

| Variable | ACOL Model | Adds Promotion Time | |
|---|---|---|---|
| | | Old ACOL | New ACOL |
| *Unit Changes:* | | | |
| Cohort Group: | | | |
| FY84 | 0.050* | 0.054* | 0.052* |
| FY85 | –0.003 | 0.024 | 0.019 |
| FY86 | 0.054* | 0.082* | 0.078* |
| FY87 | 0.117* | 0.143* | 0.147* |
| FY88 | –0.033 | –0.020 | –0.021 |
| FY89 | 0.103* | 0.152* | 0.153* |
| Occupational group: | | | |
| Electronic equipment | –0.062* | –0.022 | –0.018 |
| Communications/intelligence | 0.025 | 0.039 | 0.044 |
| Medical/dental | 0.049 | 0.082* | 0.083* |
| Other technical/allied | 0.020 | 0.049 | 0.045 |
| Functional support/ administration | 0.139* | 0.173* | 0.179* |
| Electrical/mechanical | 0.015 | 0.028 | 0.026 |
| Craftsmen | 0.003 | 0.030 | 0.026 |
| Service/supply handlers | 0.030 | 0.049* | 0.049* |
| GED certificate | –0.171* | –0.162* | –0.026 |
| Non-high-school graduate | –0.225* | –0.200* | –0.067 |
| Some post-secondary school | –0.053* | –0.112* | –0.110* |
| Black | — | — | — |
| Hispanic | 0.002 | 0.003 | 0.002 |
| Married | 0.155* | 0.146* | 0.141* |
| *Elasticities:* | | | |
| Number of dependents | 0.108* | 0.103* | 0.106* |
| AFQT score | –0.098* | –0.311* | –0.345* |
| Age at accession | 0.786* | 0.784* | 0.340* |
| ACOL (military pay) | 0.971* | 1.047* | 0.445* |
| Unemployment at accession | –0.061 | –0.046 | –0.044 |
| Unemployment at retention | 0.160* | 0.136* | 0.132* |
| Expected E5 promotion time | — | –0.852* | –0.808* |
| Correlation (ρ) | | –0.327* | –0.324* |

NOTE: Entries with asterisks are significant at the $\alpha = 0.05$ confidence level.

The "new ACOL" results show that promotion timing is important even after the timing has been monetized into the ACOL variable. Holding constant ACOL, the elasticity of retention with respect to expected E5 promotion time is –0.81. The significance of promotion timing in the "new ACOL" specification suggests that promotions may have substantial nonpecuniary value to airmen. We cannot be certain that the ACOL computation fully monetizes the value of a promotion,

however, so the promotion timing effects in the "new ACOL" specification may reflect a residual monetary benefit of the promotion that is not captured by ACOL. Nonetheless, the results show that differences in individual promotion status at the end of the first term have a substantial effect on first-term retention decisions and that these effects have not been accounted for by previous models.

As in the pay ratio model, the error term correlation between the promotion and retention equations is large at –0.33. The correlation suggests than unobserved factors that affect promotion have a substantial effect on retention as well. Airmen with unexpectedly long promotion times based on observed factors are likely to have much lower retention rates than would have been predicted from observed factors.

A comparison of the standard ACOL model with the joint promotion and retention models shows that both versions of the joint model fit better than the standard ACOL model. The $\chi^2$ associated with adding expected time to E5 to the standard ACOL model is 429.6. The $\chi^2$ associated with the "new ACOL" specification is 343.4. The 1 percent critical value of $\chi^2$ with two degrees of freedom is 9.2, so both joint models significantly improve the statistical fit of the data.

As in the Army, the retention results with the ACOL specification are quite similar to those in the military/civilian wage specification. The remainder of this subsection concentrates on differences in the results from the two models.

### Economic Conditions and Pay

The estimated military pay elasticity in the ACOL model differs substantially across different ACOL specifications. The pay elasticity is slightly larger in the "old ACOL" specification than in the standard ACOL specification: a 10 percent increase in military pay is associated with a 10 percent increase in retention. The pay elasticity in the "new ACOL" model is much lower and suggests that a 10 percent increase in military pay would yield only a 4 percent increase in retention.[4]

Unemployment has the same effect on retention in the standard pay ratio and ACOL formulations of the retention model. A 10 percent increase in unemployment at retention is associated with a 13 percent increase in retention.

[4]Carter et al. (1987) report a pay elasticity of 0.91 in a pay ratio type model for first-term retention decisions between July 1976 and June 1983.

### Soldier Characteristics

In the Air Force, it was impossible to include race, education, and age in the ACOL retention model because these variables were used in the construction of ACOL and were collinear with the ACOL index. In earlier specifications, the ACOL variable was not significantly different from zero when race, education, and age were included in the specification.[5] The reported specification drops the black variable that was an important component of civilian wage prediction in the ACOL.

As in the Army, the predicted retention for soldiers with GEDs differs between the pay ratio and ACOL models. As discussed above, this difference reflects the technical issue of what civilian opportunities are attributed to these soldiers. In the pay ratio model, soldiers with GEDs are given the civilian earnings of youth with 12 years of school. The ACOL model distinguishes only between the earnings of high school graduates and nongraduates, so airmen with GEDs are assigned the same earnings as nongraduates.

The coefficient for post-secondary schooling is larger in the ACOL specification, because civilian earnings in the ACOL model assign the same earnings to all soldiers with high school diplomas. This understates the civilian earnings opportunities of soldiers with post-secondary schooling, so it is not surprising that the estimated coefficient on post-secondary earnings is more negative in the ACOL specification. As before, the quality effects are biased by the omission of promotion timing: the estimated effect of post-secondary schooling is twice as large in the ACOL model with promotion timing as in the traditional ACOL model.

The AFQT effect is severely biased in the ACOL specification without promotion tempo. The AFQT effect is three times larger in the joint promotion and retention model than it is in the traditional ACOL specification.

The estimated effects of marital status, number of dependents, and Hispanic status are the same in both the ACOL and pay ratio specifications. As in the Army, age effects are much larger in the pay ratio model than in the ACOL specification. Age is used in the imputation of both pay variables, however, so the different age "effects" may reflect the differences in the underlying imputation algorithms.

[5]The collinearity problem makes it impossible to identify partial effects of all these variables and ACOL simultaneously. Warner and Goldberg (1984) dropped these collinear variables from their retention model and focused on the ACOL variable.

### Occupational and Cohort Differences

The occupational and cohort effects in the ACOL model are similar to those in the pay ratio model. The coefficients on the cohort variables show that retention was unusually strong in the FY84, FY86, FY87, and FY89 cohorts. The ACOL results show a slightly stronger pattern of variation by occupational area than in the pay ratio model. After controlling for promotion timing, retention rates in medical/dental, functional support and administration, and service and supply handler areas are 8, 18, and 5 percentage points higher than in the infantry/combat area. Retention rates in the other occupational areas do not differ significantly from those in the infantry/combat area.

# 7. ANALYSIS OF AIR FORCE OCCUPATIONAL AREAS

This section examines whether promotion and retention effects differ across Air Force occupational areas. The analysis considers the electronic equipment repair, functional support and administration, and electrical/mechanical repair areas. These are the largest three occupational areas in the Air Force and constitute about 60 percent of the first-term retention cohorts in our analysis. We tested whether the parameters of the constrained model for all occupational areas differed significantly from those of these three occupational areas and another composite group. The likelihood ratio test produced a $\chi^2$ of 201.7, where the critical $\chi^2$ with 130 degrees of freedom at the 1 percent level is 177.3. This result suggests that it is inappropriate to aggregate across occupational areas, because the underlying empirical parameters differ significantly across those areas.

The pay ratio and ACOL results are quite similar, so we have chosen to concentrate here on the results from the pay ratio version of the joint promotion and retention model. Expected time to E5 has a statistically significant effect on retention in occupational area, and the results of the joint model are compared across areas. The basic retention specifications without promotion timing are not reported by occupational area, but the coefficient biases correspond with those described in the last section.

## PROMOTION RESULTS FOR AIR FORCE OCCUPATIONAL AREAS

As we saw in the last section, Air Force promotion tempo varies much less than that of the Army. The promotion results in Table 7.1 show that average expected promotion time differs by only two months between the slowest and fastest of the three areas considered. The results also show a similar pattern of effects across the three areas.

### Cohort and Occupation

The promotion tempo has not varied much by cohort group in any of the occupational areas: individual cohorts may have expected pro-

**Table 7.1**

**Expected E5 Promotion Time Regressions for Air Force Occupational Areas**

| Variable | Electronic Equipment | Functional Support/ Administration | Electrical/ Mechanical |
|---|---|---|---|
| Intercept | | | |
| Cohort group: | | | |
| FY84 | –0.0334 | 0.0227 | –0.0333* |
| FY85 | –0.0309 | 0.0442* | 0.0046 |
| FY86 | –0.0310 | 0.0578* | 0.0224 |
| FY87 | –0.0146 | 0.0217 | –0.0248 |
| FY88 | 0.0106 | –0.0080 | –0.0216 |
| FY89 | –0.0389 | 0.0208 | 0.0278 |
| Occupational group: | | | |
| Job 1 | –0.0227 | –0.0406* | –0.0040 |
| Job 2 | 0.0033 | –0.0016 | 0.0186 |
| Job 3 | –0.0312 | –0.0142 | –0.0053 |
| Job 4 | — | –0.0625* | 0.0451* |
| GED certificate | –0.0048 | –0.0037 | 0.0278 |
| Non-high-school graduate | — | — | — |
| Some post-secondary school | –0.0499* | 0.0033 | 0.0094 |
| AFQT score | –0.0018* | –0.0025* | –0.0023* |
| Time to E4 | 0.0178* | 0.0147* | 0.0195* |
| Not yet E4(P) | 0.1120* | 0.0990* | 0.0845* |
| Relative promotion position (%) | 0.0049* | 0.0048* | 0.0051* |
| Selected for E5 (%) | –0.0028 | –0.0056* | –0.0052* |
| Expected E5 promotion time | 70.6140 | 72.7145 | 72.8516 |

NOTES: The omitted reference group is high school graduates in an omitted jobs category in the FY83 retention cohort. Promotion time is measured in natural logarithms. Entries with asterisks are significant at the $\alpha = 0.05$ confidence level.

"Jobs" are defined separately in each area. The electronic equipment repair jobs are radio communications; navigation, communication, and countermeasures; and electronic instruments. The functional support/administration groups are administration, data processing, supply administration, and transportation. The job groups in the electrical/mechanical repair area are general aircraft, aircraft engines, aircraft accessories, and aviation ordnance. Other area jobs are the respective reference categories.

motion times 2 or 3 percent higher or lower than those in the base year, but the differences are typically statistically insignificant. In functional support and administration, promotion tempo was 4 and 6 percent slower for airmen in the FY85 and FY86 retention cohorts, respectively, than that in the FY83 base year. In the electrical/ mechanical repair area, retention was 3 percent faster for the FY84 cohort than retention for the base year.

Promotion opportunities vary more within occupational areas than across occupational areas, but the differences are not as large as in the Army. Airmen compete against all other eligible airmen and not just those in their particular AFSC. The only real occupational advantage is for those soldiers assigned a CCS skill. In the electronic equipment repair area, promotion opportunities do not vary significantly among the three large occupations and all other airmen. In functional support and administration, administration and transportation groups have promotion tempos 4 and 6 percent faster than other jobs in the area. Airmen in aviation ordnance jobs have moved up in the promotion queue about 5 percent slower than have those in other jobs in the electrical/mechanical repair area.[1]

### Soldier Characteristics and Promotion Status

After controlling for promotion points, education level has little effect on how quickly airmen move up in the promotion queue. The only statistically significant effect is that electronic equipment repairmen with post-secondary schooling are ultimately promoted about 5 percent faster than repairmen with only a high school diploma. The sample of airmen without high school diplomas was insufficient for the area-specific analysis, so they were dropped from this portion of the analysis.

AFQT score is inversely related to promotion tempo in each occupational area. A 20 percentage point increase in AFQT score for a group of airmen is associated with a 2.5 to 3.5 decrease in expected E5 promotion time, depending on occupational area.

Time to E4 has a similar effect on expected time to E5 in each area. "Fast movers" have special, unobserved characteristics that help them move more quickly through the E5 promotion queue, even after controlling for how many points they have at the end of their first term.

For promotion-eligible airmen, relative position in the queue and the E5 selection rate have similar effects on promotion tempo in each area. This result was expected since the airmen compete across occupational areas based on their WAPS scores.

[1]The job mix in the electrical/mechanical repair area is much different in the Air Force than in the Army. The Air Force jobs are concentrated in the aircraft maintenance whereas the Army jobs are primarily related to automotive repairs.

## RETENTION RESULTS FOR AIR FORCE OCCUPATIONAL AREAS

Average retention rates for the three occupational areas range from 62 percent in the functional support and administration area to 41 percent in the electronic equipment repair area. These large differences in retention rates suggest that the Air Force may impose different demand restrictions on retention in these areas. The Air Force promotion philosophy of equal promotion opportunities restricts the availability of promotion as a retention enhancement tool in shortage skills. The Air Force authorization structure may also produce imbalances between the proportion of junior and senior airmen required in an area.

### Promotion Timing and Retention

The results in Table 7.2 show that promotion timing has an important effect on retention in each area, but that the effect differs somewhat by type of occupation. The elasticity estimates show that a 10 percent increase in expected promotion time is associated with a 10.4, 7.3, and 9.4 percent reduction in the retention rates of the electronic equipment repair, functional support/administration, and electrical/mechanical repair areas, respectively. The elasticity estimates are a little misleading, however, because the average retention rates are so different. The 10 percent (seven month) increase in promotion tempo implies about a 5 percentage point drop in retention for each area.

The error term correlations are statistically significant in each occupational area. In each case, unobserved factors that increase expected promotion time are likely to reduce the chances that the airman will reenlist.

### Economic Conditions and Pay

The military pay elasticity is more than 50 percent lower in the functional support/administration areas than in either of the other areas. A 10 percent increase in military pay is associated with a 4, 3, and 7 percentage point increase in retention in the electronic equipment repair, functional support/administration, and electrical/mechanical repair areas, respectively.

Unemployment and SRB effects are insignificant in all three areas. In part, the insignificance of these factors reflects smaller precision in

**Table 7.2**

**First-Term Retention Results for Air Force Occupational Areas**

| Variable | Electronic Equipment | Functional Support/ Administration | Electrical/ Mechanical |
|---|---|---|---|
| *Unit changes:* | | | |
| Cohort group: | | | |
| FY84 | –0.013 | 0.061 | 0.000 |
| FY85 | –0.012 | 0.043 | –0.054 |
| FY86 | –0.059 | 0.151 | 0.026 |
| FY87 | 0.100 | 0.257* | 0.134* |
| FY88 | –0.080 | 0.110 | –0.092 |
| FY89 | 0.102 | 0.255* | 0.130* |
| Occupational group: | | | |
| Job 1 | –0.015 | –0.015 | –0.033 |
| Job 2 | –0.022 | –0.113* | –0.003 |
| Job 3 | –0.049 | –0.054 | –0.035 |
| Job 4 | — | 0.021 | –0.014 |
| GED Certificate | 0.018 | 0.145* | 0.067 |
| Non-high-school graduate | — | — | — |
| Some post-secondary school | –0.088* | –0.172* | –0.111 |
| Black | –0.001 | 0.040* | 0.008 |
| Hispanic | –0.007 | 0.005 | –0.000 |
| Married | 0.104* | 0.156* | 0.152* |
| SRB multiplier = 1 | 0.040 | 0.001 | 0.018 |
| *Elasticities:* | | | |
| Number of dependents | 0.162* | 0.029 | 0.135* |
| AFQT score | –0.483* | –0.269* | –0.181* |
| SRB multiplier | 0.107 | –0.001 | 0.009 |
| Age at accession | 0.954* | 0.513* | 1.586* |
| Military/civilian pay | 1.117* | 0.502* | 1.347* |
| Unemployment at accession | 0.154 | –0.024 | –0.000 |
| Unemployment at retention | 0.236 | –0.009 | 0.086 |
| Expected E5 promotion time | –1.038* | –0.727* | –0.941* |
| Correlation (ρ) | –0.377* | –0.249* | –0.250* |
| Retention rate | 0.412 | 0.625 | 0.507 |

NOTES: "Jobs" are defined separately in each area. The electronic equipment repair jobs are radio communications; navigation, communication, and countermeasures; and electronic instruments. The functional support/administration groups are administration, data processing, supply administration, and transportation. The job groups in the electrical/mechanical repair area are general aircraft, aircraft engines, aircraft accessories, and aviation ordnance. Other area jobs are the respective reference categories.

the area-specific analysis than when all occupations were combined in Section 6. The coefficients do suggest, however, that the unemployment and SRB effects may be weaker in functional support/ administration than in the other areas.

### Soldier Characteristics

Educational attainment has similar effects on retention in all three areas: retention rates are highest for airmen with GED certificates, followed by those for airmen with high school diplomas and some post-secondary schooling, respectively. The education effect is particularly strong in functional support/administration, where airmen with GEDs have retention rates 14 percentage points above those of high school diploma graduates and airmen with post-secondary schooling have retention rates 17 percentage points lower than those with only high school training.

Marital status and number of dependents have similar effects in the three areas. Dependents have a weaker effect in the functional support/administration area, but the effect of marital status is stronger than in the other areas.

The effects of aptitude on retention differ substantially by occupational area, with the estimated elasticity almost three times as large in the electronic equipment area as in the electrical/mechanical repair area. As in the previous section, the estimated AFQT effects on retention are substantially more negative after controlling for promotion timing than in the more traditional retention model without controls for individual promotion opportunity. Other things equal, a 10 percent increase in the AFQT of a group of airmen is associated with a 5, 3, and 2 percent reduction in retention in the electronic equipment, functional support/administration, and electrical/mechanical repair areas, respectively.

### Occupations

Retention rates do not differ significantly across the major occupations within these occupation areas. None of the occupational groups have retention rates significantly above or below the average in electronic equipment and electrical/mechanical repair areas. The only anomaly in the functional support/administration area is data processing jobs, which have retention rates about 11 percentage points lower than the rest of the occupational area. Lower retention for data processing jobs may reflect the fact that these job skills are readily transferable to the civilian sector.

### Cohorts

The cohort effects are similar across the three occupational areas, but larger percentage point changes occur in those occupations with

higher overall retention rates. In each area, FY87 and FY89 were particularly strong retention years relative to the seven cohorts considered in our analysis.

# 8. SUMMARY AND CONCLUSIONS

This study has developed a new retention methodology that incorporates information on promotion status into the first-term retention decision. The results demonstrate that retention models are sensitive to the specification of individual promotion opportunities at the end of the first term. Expected time to E5 promotion has a significant effect on first-term retention in both the pay ratio and ACOL formulations of the retention model. Other things equal, a 10 percent promotion slowdown is associated with 14 and 8 percent reductions in Army and Air Force retention rates, respectively. The results show that traditional retention approaches have not adequately controlled for promotion tempo. The strong effects of promotion tempo on retention persist even in the ACOL specification that adjusts for average promotion opportunities. We also found a comparable effect of promotion timing after the promotion effect was monetized into the ACOL computation: an indication that promotions are associated with substantial nonpecuniary benefits over and above the monetary value of the promotion itself. By the end of their first term, individuals are well informed about their promotion prospects and their ability to improve them, so their retention behavior will reflect their individual promotion opportunities over and above those of the average soldier as specified in previous retention research.

Adjustment for promotion tempo is particularly important in the current environment where promotion opportunities are changing. By 1991, the average E5 promotion tempo was about 20 percent slower than in the early 1980s, so that the average soldier was waiting another 9 and 16 months for promotion in the Army and Air Force, respectively. These long delays mean that simple measures of relative military/civilian pay will not be a reliable gauge of military competitiveness vis-à-vis the civilian sector. A priori, we expected that many soldiers would be unwilling to reenlist because of these promotion delays, and the results are consistent with this hypothesis.

Our approach also shows that several key parameters of traditional models have been misleading because those models have not adjusted for promotion timing. The most important policy parameters associated with those models is the military pay elasticity, and our results show that the elasticity estimates are sensitive to individual promotion status at the end of the first term. The Army pay elasticity estimates fell about 60 percent after adjusting for promotion timing. The

pay elasticity was estimated as 1.7 and 1.8 with the pay ratio and ACOL retention approaches, respectively, but the elasticity in the joint promotion and retention models was about 1.1 with both approaches. In the Air Force, the pay elasticity was lower than in the Army, and the effect differed somewhat with model specification. The Air Force pay elasticity was estimated as 1.6 and 1.0 with the standard pay ratio and ACOL model specifications, respectively, but the estimates fell to 1.1 and 0.4 when promotion timing was incorporated into the corresponding pay ratio and ACOL models.

The joint promotion and retention framework is particularly useful for sorting out the supply effects of important measures of soldier quality. The omission of promotion tempo in traditional model specifications means that the supply estimates are biased and represent the combined effects of promotion tempo and retention. The traditional models show that AFQT score has little effect on retention, but the results from the joint model show that the AFQT effect on retention is about four times greater after controlling for promotion time—a 15 percentage point increase in AFQT score implies about a 4 percentage point retention decline. Similarly, traditional estimates have substantially overstated the "taste" of well-educated soldiers for the military. Traditional estimates show that soldiers with some post-secondary schooling have retention rates comparable with those of soldiers with only a high school diploma, but the "true" supply estimates after adjusting for promotion tempo show that these better educated soldiers have retention rates 6 and 8 percentage points lower than those of diploma graduates. Aptitude and education level have important effects on retention, but these effects are confounded by traditional retention approaches that do not adjust for individual promotion opportunities.

The detailed analysis of occupational areas has shown that key policy parameters vary significantly across occupational groups. Promotion timing remains a key variable in each Army and Air Force occupational area, but the magnitude of the pay and promotion effects differ substantially across them. These occupational differences suggest that the services should be cautious about molding their policies to models based on data aggregated across broad occupational groups. Some occupations are inherently easier to man than others and are much more responsive to pay and promotion incentives. Similarly, the results show that some occupations are much more sensitive to civilian employment opportunities than others, so manning difficulties will vary disproportionately across occupations over the business cycle.

Our analysis has relied on critical information on individual promotion points and history. This information is not maintained in the standard personnel databases, but the information is important for predicting individual promotion timing. The criteria for E5 promotion are objectively defined and clearly visible to soldiers at the end of the first term. Soldiers know how points are awarded, they know their own points, and they know their position in the promotion queue. This promotion information is a critical part of the reenlistment decision, and the services take explicit steps to advise soldiers on their promotion opportunities and steps that would improve their promotion chances.

The promotion results show the importance of controlling for promotion points and history. Some soldiers are high in the queue at the end of their first term and are assured a quick promotion if they reenlist. Other have not yet achieved eligibility for promotion to E5, and these "slow movers" have substantially worse promotion prospects than those in the promotion-eligible queue. The promotion point information captures critical information available to soldiers as they make their retention decisions, and the results show that this information is an important predictor of promotion timing even after adjusting for measured aspects of soldier quality such as AFQT score and educational attainment.

The results show that soldiers are quite sensitive to promotion tempo and that promotion could be used to complement military pay and bonus policies in retaining quality personnel in hard-to-fill skills. We have not demonstrated that the services *should* place more emphasis on promotion, but promotion policy should be an important portion of any compensation package. Unlike pay level and bonuses, promotion policies allow the services flexibility to encourage and reward individual performance, by increasing the effective relative pay of high achievers. Pay levels and bonuses help the services attract greater numbers of soldiers, but increases in promotion tempo have the unique feature of attracting both greater numbers and greater quality. Whatever the strengths or weaknesses of the promotion systems, they are the primary policy tool for retaining *quality* personnel.

Finally, we believe that the services should not rely on reduced promotion tempo to induce lower retention during the planned military drawdown. Protracted debates over the drawdown could result in stalemate and a default solution in which lower retention targets are met by stronger declines in promotion tempo. The services should be cognizant of the effect of such a drawdown on the quality of the

force—a promotion slowdown might succeed in "sweating out" the right numbers of soldiers at the retention point, but the "solution" would discourage quality soldiers from joining the career force.

# Appendix A

# A TWO-EQUATION MODEL OF PROMOTION AND REENLISTMENT

## INTRODUCTION

The outcomes *promotion* and *reenlistment* are considered as part of an integrated behavioral statistical model. Promotion depends upon the characteristics of the individual as well as the situation he finds himself in (military occupation, military needs). The time to promotion is uncertain (to the analyst), since not all factors affecting promotion can be measured. The time to promotion is a continuous random variable, but is not always observed.

Reenlistment depends upon a similar set of factors, but also includes the length of time to promotion. The reenlistment outcome has a random component because of unobserved factors. Reenlistment is a discrete outcome, either occurring or not. The mathematical model below formalizes these notions and prepares for an empirical analysis of promotion and reenlistment. The appropriate econometric estimators are then derived. Finally, we discuss the interpretation of model parameters and the use of the model for prediction.

## THE MODEL

An individual's expected time to promotion, denoted $y_1^*$, is modeled as a function of a (column) vector of observed variables, x, a (row) vector of unobserved parameters $\beta_1$, and an unobserved random error $\varepsilon_1$:[1]

$$y_1 = \beta_1 x + \varepsilon_1 \quad . \tag{A.1}$$

Expected promotion time is a latent (i.e., not directly observed) random variable. A truncation problem arises in estimation because some soldiers have not yet been promoted, and some soldiers might never be promoted. Promotion times are observed only if those times are less than or equal to actual time in military service, and many soldiers will separate before promotion to E5. Therefore, observed

[1]The individual observation subscript has been omitted for notational clarity.

time to promotion, $y_1$, is meaningful only if the individual has been promoted:

$$y_1 = \begin{cases} y_1^* \text{ if } y_1^* \leq T, \\ 0 \text{ otherwise}, \end{cases} \tag{A.2}$$

where T is the amount of time spent in the service. Actual promotion time is censored for those not yet promoted and will be some amount greater than T. It is assumed that an individual, in deciding whether or not to reenlist at the end of his term of service, weighs a vector of relevant factors, x, as well as the realized or expected time to promotion, $y_1^*$. Let $y_2^*$ measure this "propensity to reenlist." A linear model including a random component would be:

$$y_2^* = \beta_2 x + \gamma y_1^* + \varepsilon_2 \ . \tag{A.3}$$

The variable $y_2^*$ is a continuous measure of the propensity or desire to reenlist.[2] In fact the investigator observes the action reenlist, so the truncation problem here is of the zero-one variety:

$$y_2 = \begin{cases} 1 \text{ if } y_2^* > 0, \\ 0 \text{ otherwise} \ . \end{cases} \tag{A.4}$$

Equations (A.1) through (A.4) constitute a structural equation model of promotion and reenlistment. Previous military manpower models have not explicitly allowed for the expected time to promotion to affect the reenlistment decision. The model proposed here involves a censored variable, $y_1$, and a binary variable, $y_2$. Similar models have been considered by Heckman (1978), Nelson and Olson (1978), Lee (1982), and others, but there have been few empirical examples because of the complexity of the estimation procedure.[3]

The model is capable of explaining the set of four possible qualitative outcomes regarding promotion and enlistment, once stochastic assumptions are made.

[2]The factors assumed to determine reenlistment may include some or all of the factors assumed to determine promotion. Exclusions of some elements of x are affected in this notation by assigning a zero weight to those excluded factors in either equation.

[3]An empirical application using a similar model can be found in Chappell (1982).

## STOCHASTIC ASSUMPTIONS AND ESTIMATION

Assume that $\varepsilon_1$ and $\varepsilon_2$ are jointly bivariate normal with zero means and variance-covariance matrix

$$\Sigma = \begin{bmatrix} \sigma_{11} & \sigma_{12} \\ \sigma_{12} & \sigma_{22} \end{bmatrix} ,$$

that is, $V(\varepsilon_1) = \sigma_{11}$, $V(\varepsilon_2) = 1$, and $Cov(\varepsilon_1, \varepsilon_2) = \sigma_{12}$. Notice that the variance of $\varepsilon_2$ is normalized to one since the scale of $y_2^*$ is not observed. Substituting Eq. (A.1) into Eq. (A.3) and solving yields the reduced-form reenlistment equation:

$$y_2^* = (\beta_2 + \gamma\beta_1)' x + \varepsilon_2 + \gamma\varepsilon_1 . \qquad (A.5)$$

Define the standardized reduced-form error vector $\eta$:

$$\eta_1 = \varepsilon_1/\sigma_1$$

$$\eta_2 = (\varepsilon_2 + \gamma\varepsilon_1) / D ,$$

where $D = \sqrt{[1 + \gamma^2\sigma_{11} + 2\gamma\sigma_{12}]}$ and the standardized vector of critical points, $\mu$:

$$\mu_1 = (T - \beta'x) / \sigma_1$$

$$\mu_2 = -[(\beta_2 + \gamma\beta_1)' x] / D .$$

The model can be summarized by four regimes depending on whether the individual is promoted or not and whether the individual reenlists or not. Table A.1 shows how these regimes depend on model parameters and gives the underlying probability of each regime occurring. If only the dichotomous outcomes promoted and reenlisted were observed, it would be a simple matter to form a likelihood from probabilities in the last column of the table. However, the maximization of this likelihood would yield estimates only of the relative magnitudes of $\beta_1$, and they would be inefficient, since the information on the continuously varying time to promotion (for those promoted) would be ignored. There is information in the continuous variable, the time to promotion observed for those servicemen who were promoted.

**Table A.1**

**Summary of Model Regimes**

| Regime | Event in terms of $\eta$ and $\mu$ | Probability |
|---|---|---|
| Promotion and reenlistment | $\eta_1 \leq \mu_1,\ \eta_2 \geq \mu_2$ | $\Phi_2(\mu_1, -\mu_2, -\rho)$ |
| Promotion and separation | $\eta_1 \leq \mu_1,\ \eta_2 < \mu_2$ | $\Phi_2(\mu_1, \mu_2, \rho)$ |
| Not yet promoted, reenlisted | $\eta_1 > \mu_1,\ \eta_2 \geq \mu_2$ | $\Phi_2(-\mu_1, -\mu_2, \rho)$ |
| Not yet promoted, separated | $\eta_1 > \mu_1,\ \eta_2 < \mu_2$ | $\Phi_2(-\mu_1, \mu_2, -\rho)$ |

NOTE: $\Phi_2$ is the bivariate standard normal cumulative distribution function (cdf) with correlation $\rho = [\sigma_{12} + \gamma\sigma_{11}]/[D\sigma_1]$, since $\sigma_{22}$ has been normalized to 1.

Therefore, we now derive the likelihood based on the observed dependent variables defined in Eqs. (A.2) and (A.4) and the stochastic assumptions made above. The propensity to reenlist is never observed, since this is an index of utility known only to the individual. Based upon the outcome promotion, there are then two groups of outcomes: the first and second regimes contain observations in which the time to promotion has been realized, whereas the third and fourth regimes do not. For the latter two regimes, the information available takes the form of a joint probability, as indicated in Table A.1. For example, the contribution to the likelihood from an individual who is not promoted and separates is given by

$$\Pr(\eta_1 > \mu_1, \eta_2 < \mu_2) = \Phi_2(-\mu_1, \mu_2, -\rho) \ .$$

This is calculated in the likelihood as the double integral of the bivariate normal probability density function over the ranges $-\infty$ to $-\mu_1$ and to $-\infty$ to $\mu_2$. An individual who has not yet been promoted and reenlists is considered analogously. In the first and second regimes, however, the length of time an individual spends in service is observed, and the contribution to the likelihood from this kind of observation must take this time into consideration. Consider an individual who is promoted but then separates. For him, the likelihood element is the conditional probability of separating given the time to promotion multiplied by the probability of being promoted in that amount of time, or

$$\begin{aligned} &\Pr(\eta_2 < \mu_2 \mid y_1^*) \bullet \Pr(y_1^*) = \\ &\left[\Pr(\eta_2 < \mu_2, y_1^*) / \Pr(y_1^*)\right] \Pr(y_1^*) = \Pr(\eta_2 < \mu_2, y_1^*) \ . \end{aligned} \tag{A.6}$$

This is calculated in the likelihood as the single integral of a univariate normal density function over the range $-\infty$ to $\mu_2$. The particular member of the normal family of distributions is found by starting with the assumed bivariate distribution and fixing the first argument at $y_1^*$. An individual who is promoted and reenlists is considered analogously. The likelihood is the product of these probabilities for all individuals. Maximization of this function yields consistent, asymptotically efficient and asymptotically normally distributed estimates of the coefficients of the promotion equation, $\beta_2$, the coefficients of the reenlistment equation, $\beta_2$ and $\gamma$, and the distinct elements of the covariance matrix of the errors, $\sigma_{11}$ and $\sigma_{12}$.

## PARAMETER INTERPRETATION

Due to the discrete nature of the outcome variable reenlist and the bounded or truncated nature of the variable time to promotion, the model above is highly nonlinear and must be fit by maximum likelihood methods. The interpretation of parameters in nonlinear models and in simultaneous equation models is not as straightforward as in linear regression models, and is discussed here.

Notice that the time to promotion, $y_1^*$, could be separately considered. In that case, consistent estimates of the parameters of Eq. (A.1) would result from applying any of the appropriate econometric procedures known to labor economists as the analysis of duration or failure time data. These procedures, although yielding consistent estimates, would not be statistically efficient because the additional information about the individual's reenlistment outcome would be ignored. That is, knowledge of whether the individual reenlisted helps determine the length of time to promotion, through the potential correlation between $\varepsilon_1$ and $\varepsilon_2$. Nonzero correlation is likely because neither the promotion nor the reenlistment model can ever include all the relevant information, and the errors in these two models may contain some common but unobservable factors.

The situation regarding separate estimation of the reenlistment equation is even worse, in the sense that consistent estimates of a separate estimation of that equation are not possible. A potentially important cause of reenlistment is the time to promotion, and the time to promotion is an endogenous variable. That is, a simple probit analysis on the zero-one outcome reenlist or separate that tried to use the time to promotion as an explanatory variable would produce biased and inconsistent estimates, for two reasons. First, if $\rho \neq 0$, as argued above, $y_1^*$ in Eq. (A.3) is correlated with $\varepsilon_2$, violating a basic estimation assumption. Second, the time to promotion is observed

only for those servicemen who have been in the service long enough, as indicated by Eq. (A.2). Either substituting T for $y_i^*$ in Eq. (A.3) or deleting the truncated observations results in biased parameter estimates (see Heckman, 1976 and 1978).

It is always possible to estimate consistently the reduced form reenlistment equation, Eq. (A.5). Simple probit would be appropriate. Coefficients of explanatory variables would be estimates of the parameters of that equation, namely $\beta$, and $\beta$ could not be interpreted as the marginal effect of a change in a variable on the propensity to reenlist. Instead, the interpretation would be the marginal effect on the ultimate probability of the ultimate outcome reenlistment, including the effect of the variable on the time to promotion and its effect on reenlistment propensity. For example, suppose a reduced-form reenlistment equation is fit and it is found that servicemen with higher AFQT scores are less likely to reenlist. Thus, the net effect of raising AFQT requirements of new entrants would be to reduce the reenlistment rate. Suppose further, for example, that servicemen with higher AFQT scores are promoted faster ($\beta_{1k} < 0$, where k is the index of the variable AFQT), that faster promotion encourages reenlistment ($\gamma < 0$), but that servicemen with higher scores have a lower propensity to reenlist ($\beta_{2k} < 0$), perhaps because of their opportunities in the civilian sector. A negative coefficient on AFQT in a reduced-form estimation of the reenlistment equation simply indicates that, apart from sampling error, $\beta_{2k} + \gamma\beta_{1k} < 0$. The reduced-form coefficient is biased toward zero, in this case, and leads to potentially misleading policy recommendations.

## PREDICTION

Prediction in models with discrete or bounded outcomes is also not as straightforward as in linear regression models. Suppose we consider an individual with characteristics x. What is the predicted time to promotion for that individual, and will that individual reenlist or separate? To answer these questions, the full set of parameter estimates must be used. First, for an individual chosen at random from the population with characteristics x, the expected time to promotion is simply given by $\beta_1 x$. Notice that this is the expected time to promotion. The actual average time to promotion for those promoted from a sample of individuals with characteristics x will be shorter, since the right tail of the distribution will be truncated.

There are three kinds of predictions regarding reenlistment from this model. From Eq. (A.5), the unconditional probability of reenlistment is given by

$$\Pr\left(y_2^* > 0\right) = \Pr\left[\varepsilon_2 + \gamma\varepsilon_1 > -(\beta_2 + \gamma\beta_1)x\right] = \Phi_1[-\mu_2] \ ,$$

where $\Phi_1$ is the univariate standard normal cumulative distribution. Since all elements of $\mu_1$ (see the definitions above) are basic parameters of the model, estimates can be substituted to predict this probability. Reenlistment can also be predicted based upon whether or not an individual has been promoted. Predictions on reenlistment given promotion status are given by the predicted probabilities from the first and third regimes in Table A.1 above, with estimates substituted for parameters in the last column. Finally, reenlistment may be predicted by the expected time in service. This probability is given by Eq. (A.6), again with estimates replacing parameters. Which prediction is most relevant depends upon the use to which it is to be put.

# Appendix B
# ARMY REGRESSION RESULTS

Tables B.1 through B.2 report the retention model regression specifications associated with the discussion in Section 4. The log likelihood in each equation corresponds to the likelihood of a two-equation model of promotion to E5 and retention. In the base case specifications, the likelihood value relates to the two equations separately. In the specifications that add expected promotion time and error correlation, the likelihood value reflects the fact that these parameters enter the retention specification. Table B.1 reports the results for the pay ratio model for the base case without promotion and the joint promotion and retention model. Table B.2 reports the ACOL retention results with and without promotion timing. Both tables show that the likelihood value is significantly increased when promotion timing is included in the model.

Tables B.3 through B.5 report the occupation-specific promotion and retention regression results associated with the discussion in Section 5. In each equation, expected E5 promotion time is measured in natural logarithms.

**Table B.1**

**Probit Results for Army First-Term Reenlistment**

| Variable | Traditional Model without Promotion | | Adds Expected Promotion Time and Error Correlation | |
|---|---|---|---|---|
| | Coefficient | Standard Error | Coefficient | Standard Error |
| Constant | –4.9902* | 0.1984 | 2.5340* | 0.3179 |
| GED certificate | 0.4783* | 0.0754 | 0.4227* | 0.0862 |
| Non-high-school graduate | –0.7987* | 0.0708 | –0.3004* | 0.0802 |
| Some post-secondary school | 0.1221 | 0.0777 | –0.0706 | 0.0804 |
| Black | 0.0708 | 0.0374 | 0.2419* | 0.0382 |
| Hispanic | –0.0665 | 0.0848 | –0.0448 | 0.0808 |
| Cohort group: | | | | |
| FY84 | –0.0566 | 0.0553 | –0.0353 | 0.0577 |
| FY85 | 0.0834 | 0.0595 | 0.1728* | 0.0613 |
| FY86 | 0.2153* | 0.0674 | 0.3247* | 0.0689 |
| FY87 | 0.2240* | 0.0704 | 0.3088* | 0.0713 |
| FY88 | 0.4425* | 0.0683 | 0.5011* | 0.0699 |
| FY89 | 0.6168* | 0.0699 | 0.8047* | 0.0719 |
| Occupational group: | | | | |
| Electronic equipment | 0.0588 | 0.0511 | 0.2778* | 0.0534 |
| Communications/intelligence | 0.1381* | 0.0398 | 0.1447* | 0.0395 |
| Medical/dental | 0.2310* | 0.0729 | 0.5406* | 0.0777 |
| Other technical/allied | 0.1360 | 0.0929 | 0.3252* | 0.0952 |
| Functional support/ administration | 0.4067* | 0.0562 | 0.6611* | 0.0587 |
| Electrical/mechanical | 0.1484* | 0.0343 | 0.3419* | 0.0364 |
| Craftsmen | –0.0910 | 0.0555 | 0.2125* | 0.0595 |
| Service/supply handlers | 0.4720* | 0.0900 | 0.6688* | 0.1000 |
| Married | 0.3367* | 0.0356 | 0.2783* | 0.0351 |
| Number of dependents | 0.1784* | 0.0149 | 0.1552* | 0.0150 |
| SRB multiplier | 0.1386* | 0.0144 | 0.1193* | 0.0143 |
| AFQT score | –0.0020* | 0.0006 | –0.0067* | 0.0006 |
| Age at accession | 0.1014* | 0.0066 | 0.0665* | 0.0066 |
| Military/civilian pay | 1.5725* | 0.0670 | 1.0338* | 0.0688 |
| Unemployment at accession | –0.0077 | 0.0066 | –0.0088 | 0.0065 |
| Unemployment at retention | 0.0240* | 0.0073 | 0.0230* | 0.0072 |
| Ln expected E5 promotion time | | | –1.5271* | 0.0530 |
| Covariance ($\sigma_{12}$) | | | 0.0865* | 0.0052 |
| Log likelihood | –10000.631 | | –95671.868 | |
| Sample size | 12278 | | 12278 | |

NOTE: Entries with asterisks are significant at the $\alpha = 0.05$ confidence level.

## Table B.2

## ACOL-Probit Results for Army First-Term Reenlistment

| | ACOL Model Without Promotion | | Adds Expected Promotion Time and Error Correlation | | | |
|---|---|---|---|---|---|---|
| | | | Old ACOL | | New ACOL | |
| Variable | Coefficient | Standard Error | Coefficient | Standard Error | Coefficient | Standard Error |
| Constant | –1.7146* | 0.1320 | 5.1353* | 0.2524 | 4.6615* | 0.2725 |
| GED certificate | –0.5855* | 0.1076 | –0.3784* | 0.1150 | –0.3295* | 0.1123 |
| Non-high-school graduate | –0.9575* | 0.0965 | –0.4866* | 0.1050 | –0.4255* | 0.1019 |
| Some post-secondary school | 0.0187 | 0.0764 | –0.1430 | 0.0805 | –0.1437 | 0.0810 |
| Black | 0.1982* | 0.0477 | 0.2808* | 0.0492 | 0.3235* | 0.0470 |
| Hispanic | 0.1357 | 0.0839 | 0.0830 | 0.0816 | 0.0827 | 0.0824 |
| Cohort group: | | | | | | |
| FY84 | 0.0007 | 0.0533 | 0.0126 | 0.0568 | 0.0069 | 0.0570 |
| FY85 | 0.1442* | 0.0574 | 0.2298* | 0.0604 | 0.2291* | 0.0605 |
| FY86 | 0.2835* | 0.0658 | 0.3888* | 0.0684 | 0.3887* | 0.0688 |
| FY87 | 0.3314* | 0.0689 | 0.3965* | 0.0708 | 0.4002* | 0.0713 |
| FY88 | 0.5187* | 0.0671 | 0.5751* | 0.0697 | 0.5856* | 0.0702 |
| FY89 | 0.6286* | 0.0678 | 0.8581* | 0.0712 | 0.8568* | 0.0716 |
| Occupational group: | | | | | | |
| Electronic equipment | –0.0041 | 0.0497 | 0.2506* | 0.0528 | 0.2502* | 0.0529 |
| Communications/intelligence | 0.1350* | 0.0379 | 0.1559* | 0.0381 | 0.1568* | 0.0382 |
| Medical/dental | 0.1526* | 0.0701 | 0.5164* | 0.0766 | 0.5237* | 0.0765 |
| Other technical/allied | 0.1043 | 0.0922 | 0.3356* | 0.0952 | 0.3390* | 0.0956 |

**Table B.2—(continued)**

| Variable | ACOL Model Without Promotion | | Adds Expected Promotion Time and Error Correlation | | | |
|---|---|---|---|---|---|---|
| | | | Old ACOL | | New ACOL | |
| | Coefficient | Standard Error | Coefficient | Standard Error | Coefficient | Standard Error |
| Functional support/ administration | 0.3744* | 0.0526 | 0.6780* | 0.0560 | 0.6879* | 0.0564 |
| Electrical/mechanical | 0.0763* | 0.0332 | 0.3060* | 0.0358 | 0.3109* | 0.0359 |
| Craftsmen | –0.1710* | 0.0538 | 0.1826* | 0.0587 | 0.1866* | 0.0587 |
| Service/supply handlers | 0.4176* | 0.0886 | 0.6697* | 0.0993 | 0.6801* | 0.0984 |
| Married | 0.3174* | 0.0353 | 0.2659* | 0.0353 | 0.2687* | 0.0357 |
| Number of dependents | 0.1816* | 0.0147 | 0.1560* | 0.0151 | 0.1583* | 0.0152 |
| AFQT score | –0.0010 | 0.0006 | –0.0064* | 0.0006 | –0.0064* | 0.0006 |
| Age at accession | 0.0469* | 0.0066 | 0.0365* | 0.0067 | 0.0359* | 0.0068 |
| ACOL | 0.1151* | 0.0118 | 0.0934* | 0.0120 | 0.0889* | 0.0120 |
| Unemployment at accession | –0.0087 | 0.0065 | –0.0099 | 0.0065 | –0.0099 | 0.0065 |
| Unemployment at retention | 0.0243* | 0.0072 | 0.0237* | 0.0072 | 0.0239* | 0.0073 |
| Ln expected E5 promotion time | | | –1.6468* | 0.0520 | –1.5248* | 0.0552 |
| Covariance ($\sigma_{12}$) | | | 0.0843* | 0.0053 | 0.0738* | 0.0054 |
| Log likelihood | –10284.02 | | –9689.836 | | –9692.259 | |
| Sample size | 12278 | | 12278 | | 12278 | |

NOTE: Entries with asterisks are significant at the $\alpha = 0.05$ confidence level.

**Table B.3**

**Joint Retention and Promotion Results for Army Infantry Area**

| | Promotion | | Retention | |
|---|---|---|---|---|
| Variable | Coefficient | Standard Error | Coefficient | Standard Error |
| Constant | 2.9758* | 0.0449 | 0.3910 | 0.5528 |
| GED certificate | –0.1217* | 0.0569 | 0.5491 | 0.2914 |
| Non-high-school graduate | 0.0509 | 0.0481 | –0.2987 | 0.2191 |
| Some post-secondary | –0.0128 | 0.0287 | –0.0139 | 0.1366 |
| Black | | | 0.1590* | 0.0707 |
| Hispanic | | | –0.0181 | 0.1493 |
| Cohort group: | | | | |
| FY84 | –0.0508* | 0.0216 | –0.1312 | 0.1007 |
| FY85 | –0.0102 | 0.0220 | 0.0102 | 0.1072 |
| FY86 | 0.0678* | 0.0218 | 0.2098 | 0.1187 |
| FY87 | 0.0385 | 0.0220 | 0.2388 | 0.1244 |
| FY88 | 0.0894* | 0.0229 | 0.3970* | 0.1228 |
| FY89 | 0.1055* | 0.0242 | 0.6093* | 0.1287 |
| Occupational group: | | | | |
| General infantry | –0.0160 | 0.0130 | 0.0199 | 0.0661 |
| Armor | 0.0123 | 0.0232 | 0.2823* | 0.1012 |
| Combat engineering | 0.0642* | 0.0154 | 0.2524* | 0.0830 |
| Married | | | 0.3089* | 0.0621 |
| Number of dependents | | | 0.1757* | 0.0260 |
| SRB multiplier | | | 0.1841* | 0.0274 |
| AFQT score | –0.0014 | 0.0002 | –0.0043* | 0.0011 |
| Age at accession | | | 0.0759* | 0.0119 |
| Military/civilian pay | | | 1.2275* | 0.1283 |
| Unemployment at accession | | | –0.0015 | 0.0112 |
| Unemployment at retention | | | 0.0272* | 0.0129 |
| Time to E4 | 0.0118* | 0.0007 | | |
| Time to E4(P) | 0.0171* | 0.0010 | | |
| Not yet E4(P) | 0.0972* | 0.0116 | | |
| Promotion point score | –0.0371* | 0.0074 | | |
| Ln expected E5 promotion time | | | –1.1667* | 0.0895 |
| Covariance ($\sigma_{12}$) | | | 0.0727* | 0.0080 |
| Log likelihood | | | –3198.998 | |
| Sample size | | | 4067 | |

NOTE: Entries with asterisks are significant at the $\alpha = 0.05$ confidence level.

## Table B.4

### Joint Retention and Promotion Results for Army Communications/Intelligence Area

| | Promotion | | Retention | |
|---|---|---|---|---|
| Variable | Coefficient | Standard Error | Coefficient | Standard Error |
| Constant | 2.9424* | 0.0706 | 0.8990 | 0.8967 |
| GED certificate | –0.0533 | 0.1158 | 0.1495 | 0.5757 |
| Non-high-school graduate | 0.1160 | 0.0886 | –0.4939 | 0.3878 |
| Some post-secondary school | –0.0435 | 0.0384 | 0.0011 | 0.1935 |
| Black | | | 0.0629 | 0.1072 |
| Hispanic | | | 0.0501 | 0.2237 |
| Cohort group: | | | | |
| FY84 | –0.0913* | 0.0348 | –0.1746 | 0.1599 |
| FY85 | –0.0615 | 0.0364 | –0.0288 | 0.1765 |
| FY86 | 0.0404 | 0.0332 | 0.1179 | 0.1904 |
| FY87 | 0.0924* | 0.0352 | 0.1672 | 0.2031 |
| FY88 | 0.1360* | 0.0360 | 0.4217 | 0.1968 |
| FY89 | 0.1252* | 0.0360 | 0.4463* | 0.3030 |
| Occupational group: | | | | |
| Radio code | 0.0531* | 0.0210 | 0.0784 | 0.1090 |
| Signal intercept | 0.0192 | 0.0254 | –0.2754* | 0.1364 |
| Combat operations control | –0.0619* | 0.0199 | –0.3749* | 0.0987 |
| Signal analysis | –0.0926* | 0.0308 | –0.1861 | 0.1778 |
| Married | | | 0.3348* | 0.0980 |
| Number of dependents | | | 0.1699* | 0.0457 |
| SRB multiplier | | | 0.1305* | 0.0354 |
| AFQT score | –0.0020* | 0.0004 | –0.0069* | 0.0019 |
| Age at accession | | | 0.0952 | 0.0191 |
| Military/civilian pay | | | 1.2977* | 0.2019 |
| Unemployment at accession | | | –0.0039 | 0.0179 |
| Unemployment at retention | | | 0.0156 | 0.0199 |
| Time to E4 | 0.0107* | 0.0012 | | |
| Time to E4(P) | 0.0203* | 0.0017 | | |
| Not yet E4(P) | 0.0921* | 0.0173 | | |
| Promotion point score | –0.0265* | 0.0104 | | |
| Ln expected E5 promotion time | | | –1.2049 | 0.1405 |
| Covariance ($\sigma_{12}$) | | | 0.0662 | 0.0125 |
| Log likelihood | | | –1322.301 | |
| Sample size | | | 1691 | |

NOTE: Entries with asterisks are significant at the $\alpha = 0.05$ confidence level.

**Table B.5**

**Joint Retention and Promotion Results for Army Electrical/Mechanical Repair Area**

| | Promotion | | Retention | |
|---|---|---|---|---|
| Variable | Coefficient | Standard Error | Coefficient | Standard Error |
| Constant | 3.2053 | 0.0571 | 5.1392* | 0.7358 |
| GED certificate | 0.0375 | 0.0368 | 0.4392* | 0.1372 |
| Non-high-school graduate | 0.0672* | 0.0288 | –0.2161 | 0.1282 |
| Some post-secondary school | 0.0193 | 0.0749 | 0.1205 | 0.2826 |
| Black | | | 0.3410* | 0.0765 |
| Hispanic | | | –0.2086 | 0.1579 |
| Cohort group: | | | | |
| FY84 | 0.0253 | 0.0270 | 0.2202 | 0.1232 |
| FY85 | 0.0810* | 0.0288 | 0.4088* | 0.1329 |
| FY86 | 0.0905* | 0.0307 | 0.5273* | 0.1514 |
| FY87 | 0.0048 | 0.0262 | 0.3794* | 0.1479 |
| FY88 | 0.0852* | 0.0292 | 0.6184* | 0.1438 |
| FY89 | 0.1891* | 0.0306 | 1.0337* | 0.1499 |
| Occupational group: | | | | |
| General automotive | 0.0527* | 0.1938 | 0.0521 | 0.0824 |
| Track vehicle | –0.0399 | 0.0233 | –0.1933 | 0.0998 |
| Construction equipment | 0.0773* | 0.0354 | 0.0488 | 0.1351 |
| Wire communications linemen | 0.1965* | 0.0325 | 0.2008 | 0.1255 |
| Married | | | 0.2047* | 0.0742 |
| Number of dependents | | | 0.1493* | 0.0324 |
| SRB multiplier | | | 0.1363* | 0.0378 |
| AFQT score | –0.0018* | 0.0003 | –0.0074* | 0.0015 |
| Age at accession | | | 0.0432* | 0.144 |
| Military/civilian pay | | | 0.8038* | 0.1390 |
| Unemployment at accession | | | –0.0288* | 0.0143 |
| Unemployment at retention | | | 0.0341* | 0.0151 |
| Time to E4 | 0.0043* | 0.0009 | | |
| Time to E4(P) | 0.0162* | 0.0013 | | |
| Not yet E4(P) | 0.1735* | 0.0162 | | |
| Promotion point score | –0.0617* | 0.0094 | | |
| Ln expected E5 promotion time | | | –1.9065* | 0.1296 |
| Covariance ($\sigma_{12}$) | | | 0.0698* | 0.0123 |
| Log likelihood | | | –2271.83 | |
| Sample size | | | 3175 | |

NOTE: Entries with asterisks are significant at the $\alpha = 0.05$ confidence level.

# Appendix C
# AIR FORCE REGRESSION RESULTS

**Table C.1**

**Probit Results for Air Force First-Term Reenlistment**

| Variable | Traditional Model Without Promotion | | Adds Expected Promotion Time and Error Correlation | |
|---|---|---|---|---|
| | Coefficient | Standard Error | Coefficient | Standard Error |
| Constant | –3.6671* | 0.2381 | 1.3607* | 0.4510 |
| GED certificate | 0.0845 | 0.0656 | 0.1423* | 0.0688 |
| Non-high-school graduate | –0.5492* | 0.2208 | –0.3941 | 0.2199 |
| Some post-secondary school | –0.0834 | 0.0478 | –0.2313* | 0.0502 |
| Black | 0.1239* | 0.0432 | 0.1956* | 0.0450 |
| Hispanic | –0.0683 | 0.0649 | –0.0123 | 0.0660 |
| Cohort group: | | | | |
| FY84 | 0.1085* | 0.0527 | 0.1221* | 0.0536 |
| FY85 | –0.0260 | 0.0540 | 0.0375 | 0.0552 |
| FY86 | 0.1116 | 0.0665 | 0.1764* | 0.0683 |
| FY87 | 0.3553* | 0.0671 | 0.4214* | 0.0692 |
| FY88 | –0.0405 | 0.0649 | –0.0042 | 0.0676 |
| FY89 | 0.3258* | 0.0704 | 0.4477* | 0.0740 |
| Occupational group: | | | | |
| Electronic equipment | –0.1361* | 0.0519 | –0.0385 | 0.0542 |
| Communications/intelligence | 0.0525 | 0.0672 | 0.0868 | 0.0687 |
| Medical/dental | 0.0164 | 0.0678 | 0.0927 | 0.0708 |
| Other technical/allied | –0.0292 | 0.0729 | 0.0392 | 0.0752 |
| Functional support/ administration | 0.2607* | 0.0508 | 0.3412* | 0.0527 |
| Electrical/mechanical | 0.0256 | 0.0466 | 0.0577 | 0.0481 |
| Craftsmen | –0.0634 | 0.0608 | 0.0020 | 0.0630 |
| Service/supply handlers | 0.0011 | 0.0549 | 0.0481 | 0.0570 |
| Married | 0.4067* | 0.0347 | 0.3848* | 0.0359 |
| Number of dependents | 0.0724* | 0.0174 | 0.0691* | 0.0181 |
| SRB multiplier = 1 | 0.1025* | 0.0347 | 0.0998* | 0.0359 |
| SRB multiplier | 0.0049 | 0.0075 | 0.0060 | 0.0078 |
| AFQT score | –0.0012 | 0.0006 | –0.0054* | 0.0007 |
| Age at accession | 0.0843* | 0.0081 | 0.0708* | 0.0084 |
| Military/civilian pay | 1.3739* | 0.0855 | 1.2158* | 0.0890 |
| Unemployment at accession | –0.0085 | 0.0062 | –0.0065 | 0.0064 |
| Unemployment at retention | 0.0285* | 0.0070 | 0.0246* | 0.0072 |
| Ln expected E5 promotion time | | | –1.0273* | 0.0825 |
| Covariance ($\sigma_{12}$) | | | –0.0202* | 0.0055 |
| Log likelihood | –7428.6334 | | –7286.1449 | |
| Sample size | 12,490 | | 12,490 | |

NOTE: Entries with asterisks are significant at the $\alpha = 0.05$ confidence level.

## Table C.2

## ACOL-Probit Results for Air Force First-Term Reenlistment

| | Traditional Model Without Promotion | | Adds Expected Promotion Time and Error Correlation | | | |
|---|---|---|---|---|---|---|
| | | | Old ACOL | | New ACOL | |
| Variable | Coefficient | Standard Error | Coefficient | Standard Error | Coefficient | Standard Error |
| Constant | –0.7884* | 0.1482 | 3.8764* | 0.3969 | 4.0471* | 0.3984 |
| GED certificate | –0.1208 | 0.0710 | –0.4138* | 0.0856 | –0.0512 | 0.0741 |
| Non-high-school graduate | –0.2655 | 0.2240 | –0.5173* | 0.2295 | –0.1522 | 0.2252 |
| Some post-secondary school | –0.1319* | 0.0482 | –0.2822* | 0.0504 | –0.2758* | 0.0505 |
| Hispanic | 0.0283 | 0.0626 | 0.1007 | 0.0644 | 0.0623 | 0.0642 |
| Cohort group: | | | | | | |
| FY84 | 0.1180* | 0.0514 | 0.1368* | 0.0526 | 0.1288* | 0.0525 |
| FY85 | –0.0134 | 0.0519 | 0.0603 | 0.0535 | 0.0488 | 0.0534 |
| FY86 | 0.1331* | 0.0593 | 0.2054* | 0.0609 | 0.1949* | 0.0610 |
| FY87 | 0.2990* | 0.0642 | 0.3622* | 0.0663 | 0.3713* | 0.0665 |
| FY88 | –0.0916 | 0.0613 | –0.0504 | 0.0642 | –0.0538 | 0.0643 |
| FY89 | 0.2560* | 0.0675 | 0.3842* | 0.0709 | 0.3876* | 0.0715 |
| Occupational group: | | | | | | |
| Electronic equipment | –0.1464* | 0.0514 | –0.0555 | 0.0537 | –0.0442 | 0.0537 |
| Communications/intelligence | 0.0743 | 0.0658 | 0.0988 | 0.0674 | 0.1102 | 0.0673 |
| Medical/dental | 0.1356* | 0.0672 | 0.2066* | 0.0698 | 0.2095* | 0.0701 |
| Other technical/allied | 0.0479 | 0.0720 | 0.1217 | 0.0747 | 0.1115 | 0.0744 |
| Functional support/administration | 0.3757* | 0.0499 | 0.4394* | 0.0519 | 0.4567* | 0.0519 |

**Table C.2—(continued)**

| Variable | Traditional Model Without Promotion | | Adds Expected Promotion Time and Error Correlation | | | |
|---|---|---|---|---|---|---|
| | | | Old ACOL | | New ACOL | |
| | Coefficient | Standard Error | Coefficient | Standard Error | Coefficient | Standard Error |
| Electrical/mechanical | 0.0348 | 0.0459 | 0.0693 | 0.0474 | 0.0647 | 0.0473 |
| Craftsmen | 0.0037 | 0.0597 | 0.0750 | 0.0623 | 0.0640 | 0.0621 |
| Service/supply handlers | 0.0816 | 0.0541 | 0.1225* | 0.0563 | 0.1249* | 0.0563 |
| Married | 0.3810* | 0.0341 | 0.3671* | 0.0357 | 0.3563* | 0.0355 |
| Number of dependents | 0.0797* | 0.0172 | 0.0743* | 0.0180 | 0.0765* | 0.0180 |
| AFQT score | –0.0030* | 0.0006 | –0.0066* | 0.0007 | –0.0075* | 0.0007 |
| Age at accession | 0.0268* | 0.0069 | 0.0514* | 0.0079 | 0.0224* | 0.0072 |
| ACOL | 0.0407* | 0.0060 | 0.1002* | 0.0095 | 0.0389* | 0.0063 |
| Unemployment at acc. | –0.0093 | 0.0061 | –0.0073 | 0.0063 | –0.0071 | 0.0063 |
| Unemployment at ret. | 0.0283* | 0.0069 | 0.0247* | 0.0072 | 0.0240* | 0.0072 |
| Ln expected E5 promotion time | | | –1.0932* | 0.0805 | –1.0564* | 0.0805 |
| Covariance ($\sigma_{12}$) | | | –0.0259* | 0.0055 | –0.0266* | 0.0056 |
| Log likelihood | –7646.1282 | | –7431.3198 | | –7474.4184 | |
| Sample size | 12,490 | | 12,490 | | 12,490 | |

NOTE: Entries with asterisks are significant at the $\alpha = 0.05$ confidence level.

## Table C.3

## Joint Retention and Promotion Results for Air Force's Electronic Equipment Repair Area

| | Promotion | | Retention | |
|---|---|---|---|---|
| Variable | Coefficient | Standard Error | Coefficient | Standard Error |
| Constant | 3.7258* | 0.0695 | 2.0636 | 1.1584 |
| GED certificate | –0.0038 | 0.0479 | 0.0451 | 0.1959 |
| Some post-secondary school | –0.0494* | 0.0193 | –0.2318* | 0.0996 |
| Black | | | –0.0130 | 0.1402 |
| Hispanic | | | –0.2438 | 0.1871 |
| Cohort group: | | | | |
| FY84 | –0.0327 | 0.0264 | –0.0342 | 0.1408 |
| FY85 | –0.0309 | 0.0254 | –0.0314 | 0.1438 |
| FY86 | –0.0320 | 0.0293 | –0.1536 | 0.1843 |
| FY87 | –0.0156 | 0.0310 | 0.2515 | 0.1697 |
| FY88 | 0.0076 | 0.0378 | –0.2120 | 0.1773 |
| FY89 | –0.0403 | 0.0480 | 0.2579 | 0.2012 |
| Occupational group: | | | | |
| Radio communications | –0.0223 | 0.0203 | –0.0371 | 0.0902 |
| Navigation, communications, and countermeasures | 0.0032 | 0.0207 | –0.0564 | 0.0902 |
| Electronic instruments | –0.0311 | 0.0202 | –0.1252 | 0.0867 |
| Married | | | 0.2669* | 0.0941 |
| Number of dependents | | | 0.1008* | 0.0495 |
| SRB multiplier = 1 | | | 0.1022 | 0.0982 |
| SRB multiplier | | | 0.0427* | 0.0211 |
| AFQT score | –0.0018* | 0.0004 | –0.0068* | 0.0021 |
| Age at accession | | | 0.0513* | 0.0207 |
| Military/civilian pay | | | 1.1335* | 0.2276 |
| Unemployment at accession | | | 0.0202 | 0.0166 |
| Unemployment at retention | | | 0.0350 | 0.0189 |
| Time to E4 | 0.0178* | 0.0013 | | |
| Not yet E4(P) | 0.1094* | 0.0401 | | |
| Relative promotion position (percent) | 0.0049* | 0.0003 | | |
| Percent selected for E5 | –0.0029* | 0.0020 | | |
| Ln expected E5 promotion time | | | –1.0997* | 0.2095 |
| Covariance ($\sigma_{12}$) | | | –0.0361* | 0.0146 |
| Log likelihood | | | –1221.0782 | |
| Sample size | | | 2006 | |

NOTE: Entries with asterisks are significant at the $\alpha = 0.05$ confidence level.

## Table C.4

### Joint Retention and Promotion Results for Air Force's Functional Support and Administration Area

| | Promotion | | Retention | |
|---|---|---|---|---|
| Variable | Coefficient | Standard Error | Coefficient | Standard Error |
| Constant | 3.8295* | 0.0442 | 3.7422* | 1.1226 |
| GED certificate | –0.0033 | 0.0271 | 0.4278* | 0.2011 |
| Some post-secondary school | 0.0030 | 0.0207 | –0.4368* | 0.1226 |
| Black | 0.1094* | | 0.2508* | 0.1017 |
| Hispanic | | | 0.1538 | 0.1469 |
| Cohort group: | | | | |
| FY84 | 0.0228 | 0.0202 | 0.1545 | 0.1312 |
| FY85 | 0.0446* | 0.0192 | 0.1086 | 0.1354 |
| FY86 | 0.0579* | 0.0218 | 0.3868 | 0.1982 |
| FY87 | 0.0220 | 0.0232 | 0.6967* | 0.2121 |
| FY88 | –0.0082 | 0.0269 | 0.2780 | 0.2014 |
| FY89 | 0.0201 | 0.0328 | 0.6895* | 0.2192 |
| Occupational group: | | | | |
| Administration | –0.0406* | 0.0172 | –0.0392 | 0.0916 |
| Data processing | –0.0016 | 0.0215 | –0.2930* | 0.1131 |
| Supply administration | –0.0141 | 0.0176 | –0.1422 | 0.0940 |
| Transportation | –0.0621* | 0.0223 | 0.0582 | 0.1176 |
| Married | 0.0147* | 0.0008 | 0.4134* | 0.0910 |
| Number of dependents | | | 0.0262 | 0.0447 |
| SRB multiplier = 1 | | | 0.0028 | 0.1156 |
| SRB multiplier | | | 0.0014 | 0.0221 |
| AFQT score | –0.0025* | 0.0002 | –0.0075* | 0.0019 |
| Age at accession | | | 0.0428* | 0.0205 |
| Military/civilian pay | | | 0.7489* | 0.2213 |
| Unemployment at accession | | | –0.0050 | 0.0163 |
| Unemployment at retention | | | –0.0020 | 0.0181 |
| Time to E4 | –0.0025* | 0.0002 | | |
| Not yet E4(P) | 0.0970* | 0.0272 | | |
| Relative promotion position (percent) | 0.0048* | 0.0003 | | |
| Percent selected for E5 | –0.0056** | 0.0016 | | |
| Ln expected E5 promotion time | | | –1.1984* | 0.1997 |
| Covariance ($\sigma_{12}$) | | | –0.0087 | 0.0130 |
| Log likelihood | | | –1044.3596 | |
| Sample size | | | 2043 | |

NOTE: Entries with asterisks are significant at the $\alpha = 0.05$ confidence level.

## Table C.5

## Joint Retention and Promotion Results for Air Force's Electrical/Mechanical Repair Area

| | Promotion | | Retention | |
|---|---|---|---|---|
| Variable | Coefficient | Standard Error | Coefficient | Standard Error |
| Constant | 3.6413* | 0.0446 | 1.2254 | 0.9048 |
| GED certificate | 0.0278 | 0.0230 | 0.1688 | 0.1215 |
| Some post-secondary school | 0.0086 | 0.0268 | –0.2814* | 0.1393 |
| Black | | | 0.0973 | 0.0904 |
| Hispanic | | | 0.0071 | 0.1244 |
| Cohort group: | | | | |
| FY84 | –0.0328* | 0.0166 | 0.0000 | 0.1090 |
| FY85 | 0.0048 | 0.0159 | –0.1356 | 0.1172 |
| FY86 | 0.0222 | 0.0179 | 0.0642 | 0.1445 |
| FY87 | –0.0249 | 0.0204 | 0.3468* | 0.1371 |
| FY88 | –0.0231 | 0.0276 | –0.2331 | 0.1407 |
| FY89 | 0.0260 | 0.0376 | 0.3309* | 0.1488 |
| Occupational group: | | | | |
| Aircraft, general | –0.0043 | 0.0136 | –0.0833 | 0.0656 |
| Aircraft engines | 0.0177 | 0.0188 | –0.0069 | 0.0881 |
| Aircraft accessories | –0.0051 | 0.0157 | –0.0881 | 0.0734 |
| Aviation ordnance | 0.0445* | 0.0187 | –0.0361 | 0.0864 |
| Married | | | 0.3837* | 0.0694 |
| Number of dependents | | | 0.0972* | 0.0354 |
| SRB multiplier = 1 | | | 0.0441 | 0.0743 |
| SRB multiplier | | | 0.0052 | 0.0183 |
| AFQT score | –0.0023* | 0.0002 | –0.0043* | 0.0014 |
| Age at accession | | | 0.1046* | 0.0169 |
| Military/civilian pay | | | 1.5746* | 0.1655 |
| Unemployment at accession | | | –0.0000 | 0.0130 |
| Unemployment at retention | | | 0.0154 | 0.0138 |
| Time to E4 | 0.0195* | 0.0011 | | |
| Not yet E4(P) | 0.0801* | 0.0221 | | |
| Relative promotion position (percent) | 0.0051* | 0.0002 | | |
| Percent selected for E5 | –0.0053* | 0.0010 | | |
| Ln expected E5 promotion time | | | –1.1973* | 0.1635 |
| Covariance ($\sigma_{12}$) | | | –0.0071 | 0.0113 |
| Log likelihood | | | –2016.6983 | |
| Sample size | | | 2043 | |

NOTE: Entries with asterisks are significant at the $\alpha = 0.05$ confidence level.

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